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JULY 1949

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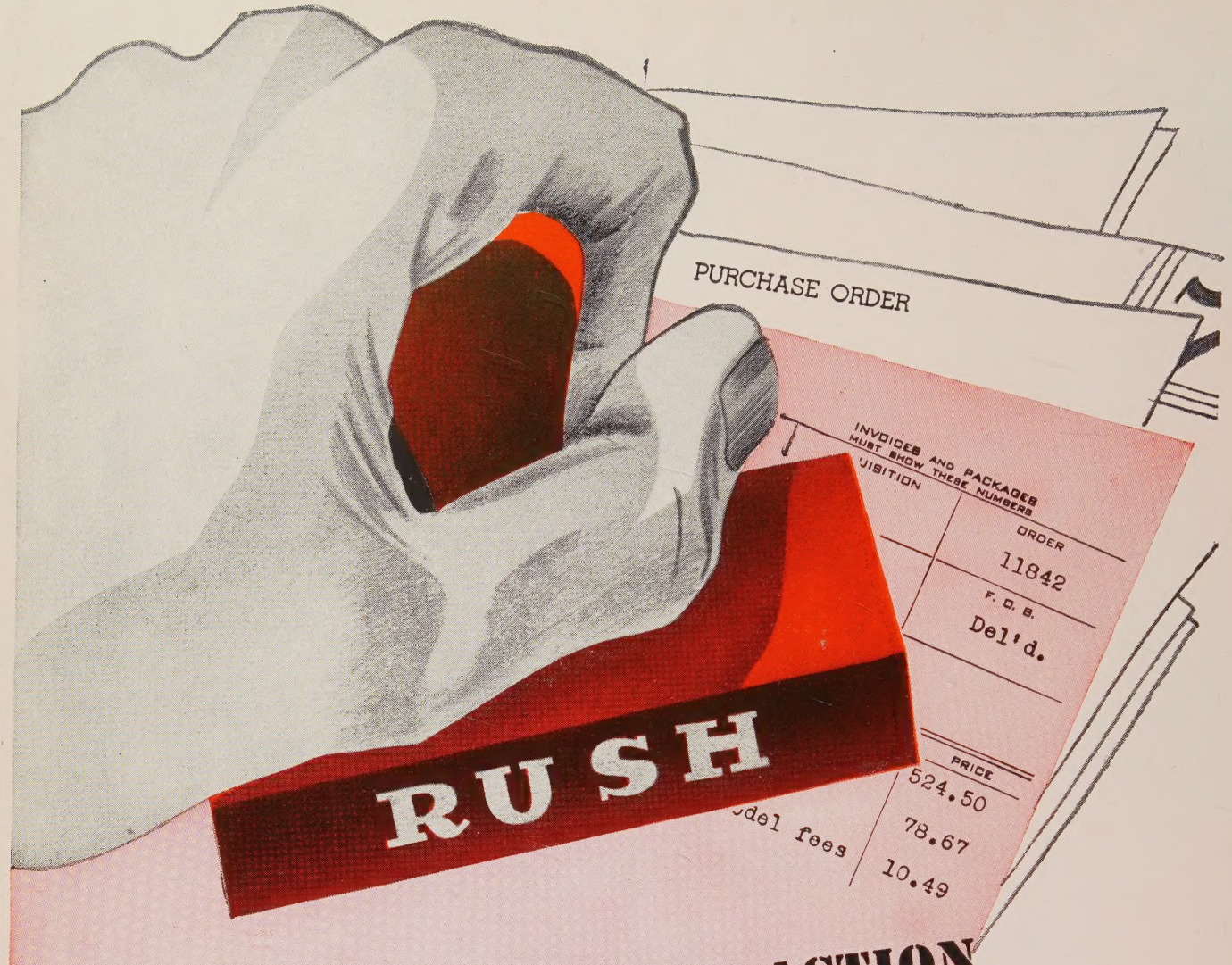

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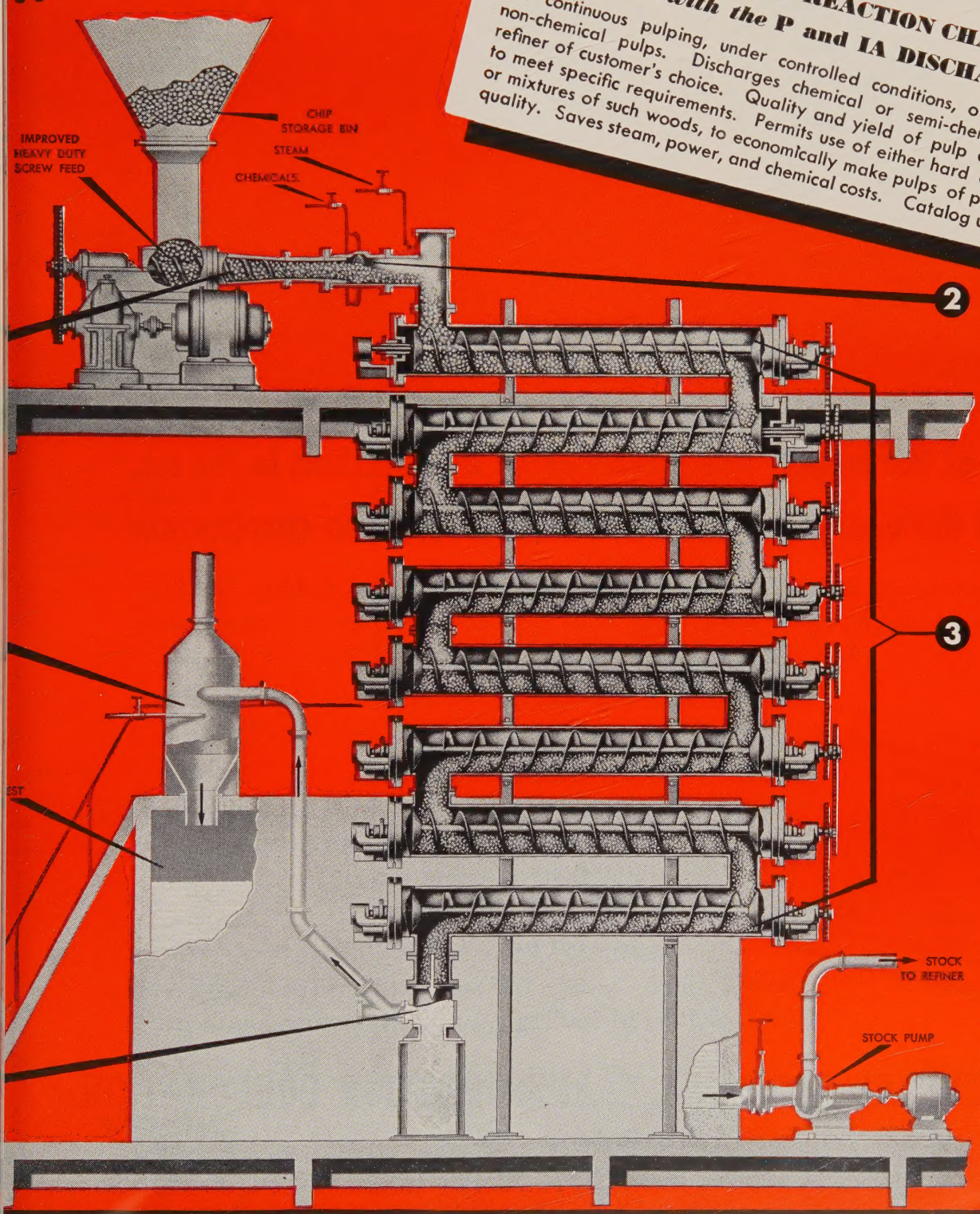

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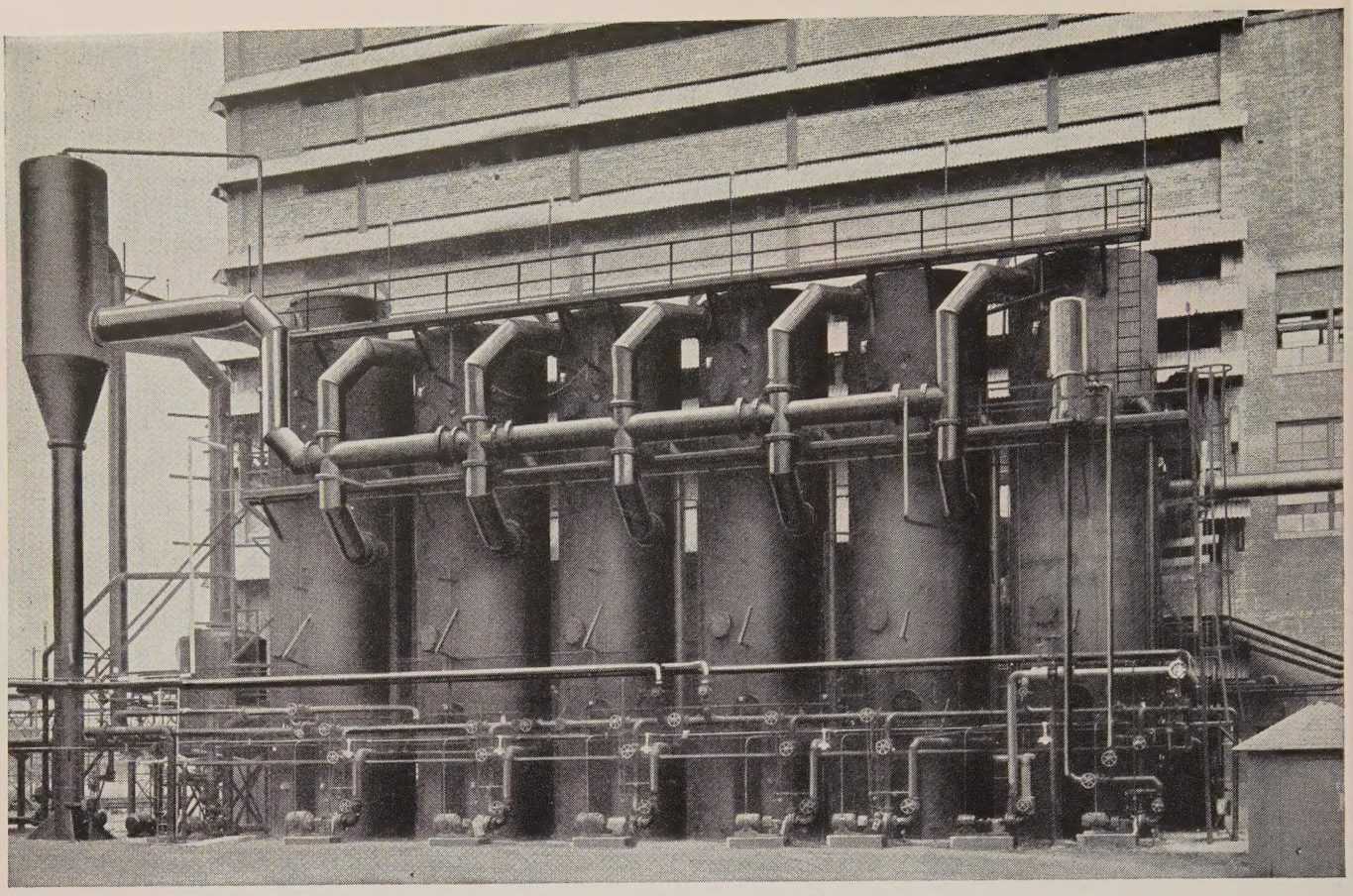

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Many paper manufacturers report that excellent results are obtained in the control of pitch trouble through the timely and consistent addition of Celite* in correct quantities. About 1% of Celite, based on the weight of the pulp processed, usually does the job.

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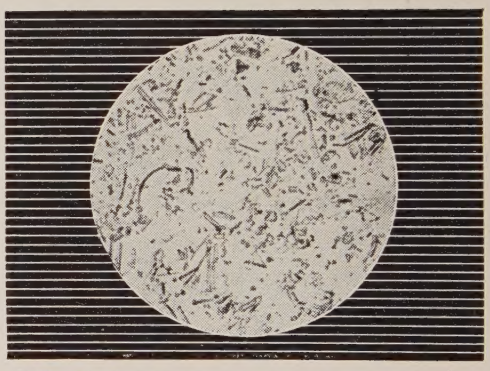

This photomicrograph shows the minute, porous Celite diatoms which coat pitch particles, destroy their stickiness and prevent build-up of pitch agglomerates.

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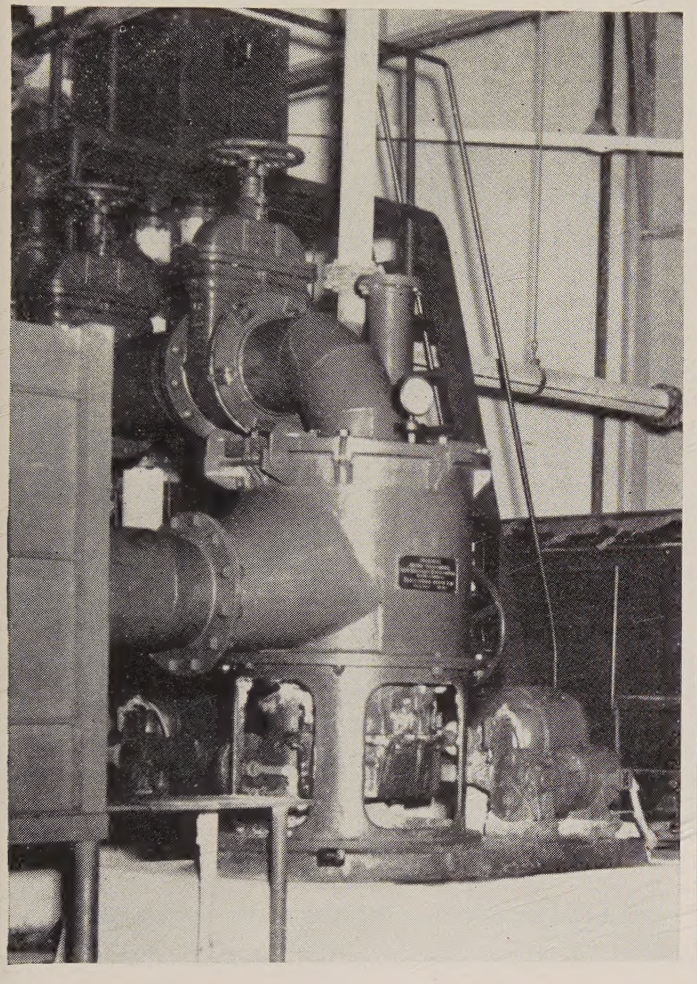

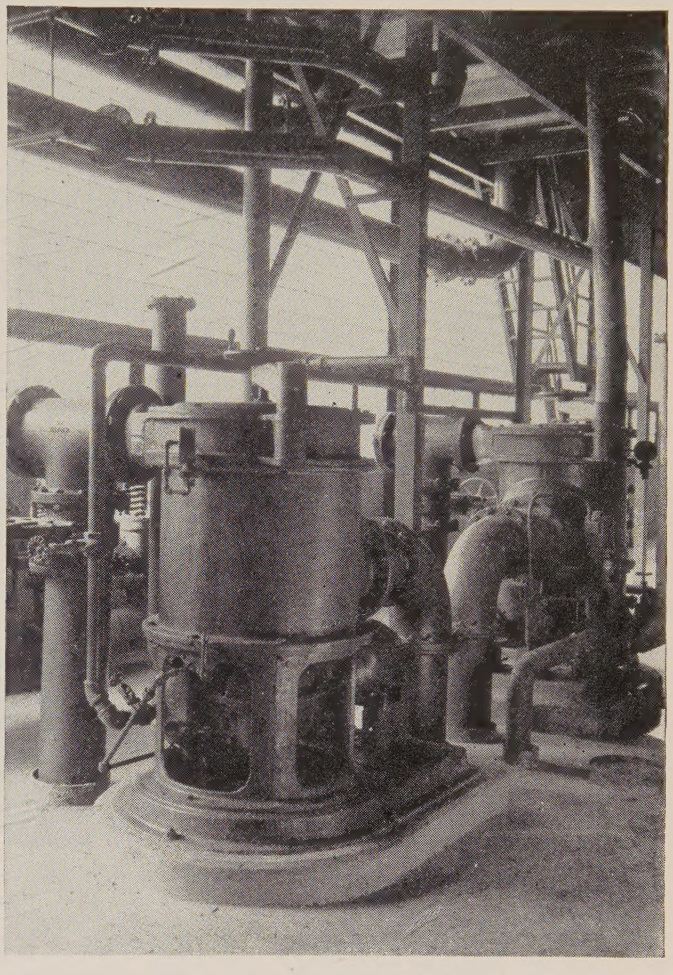

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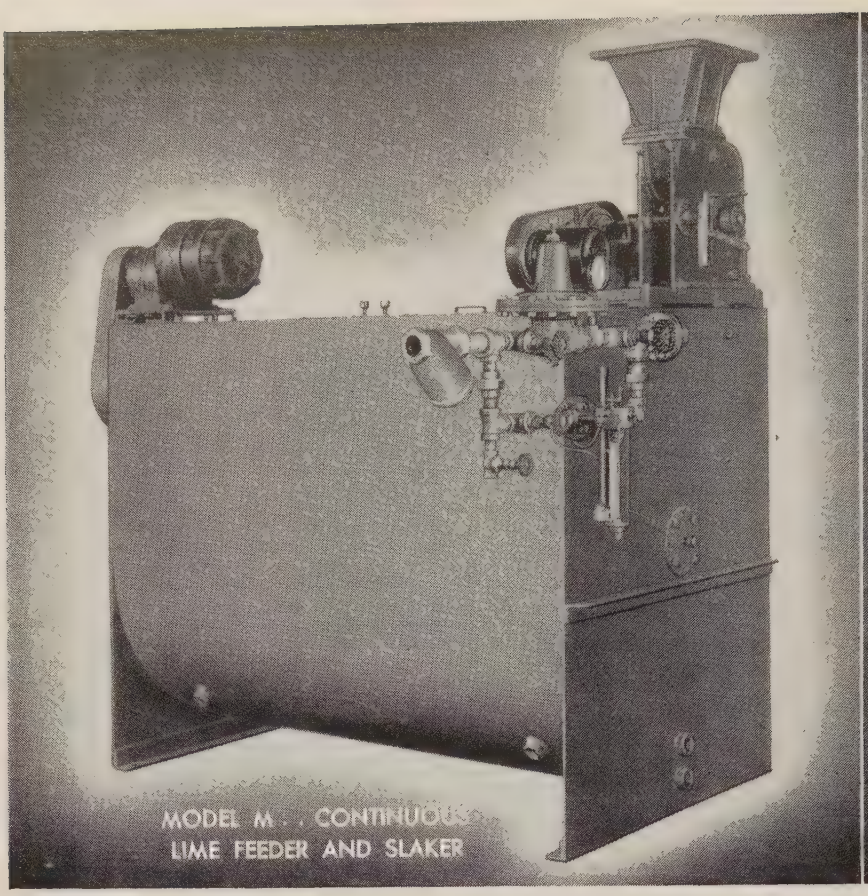

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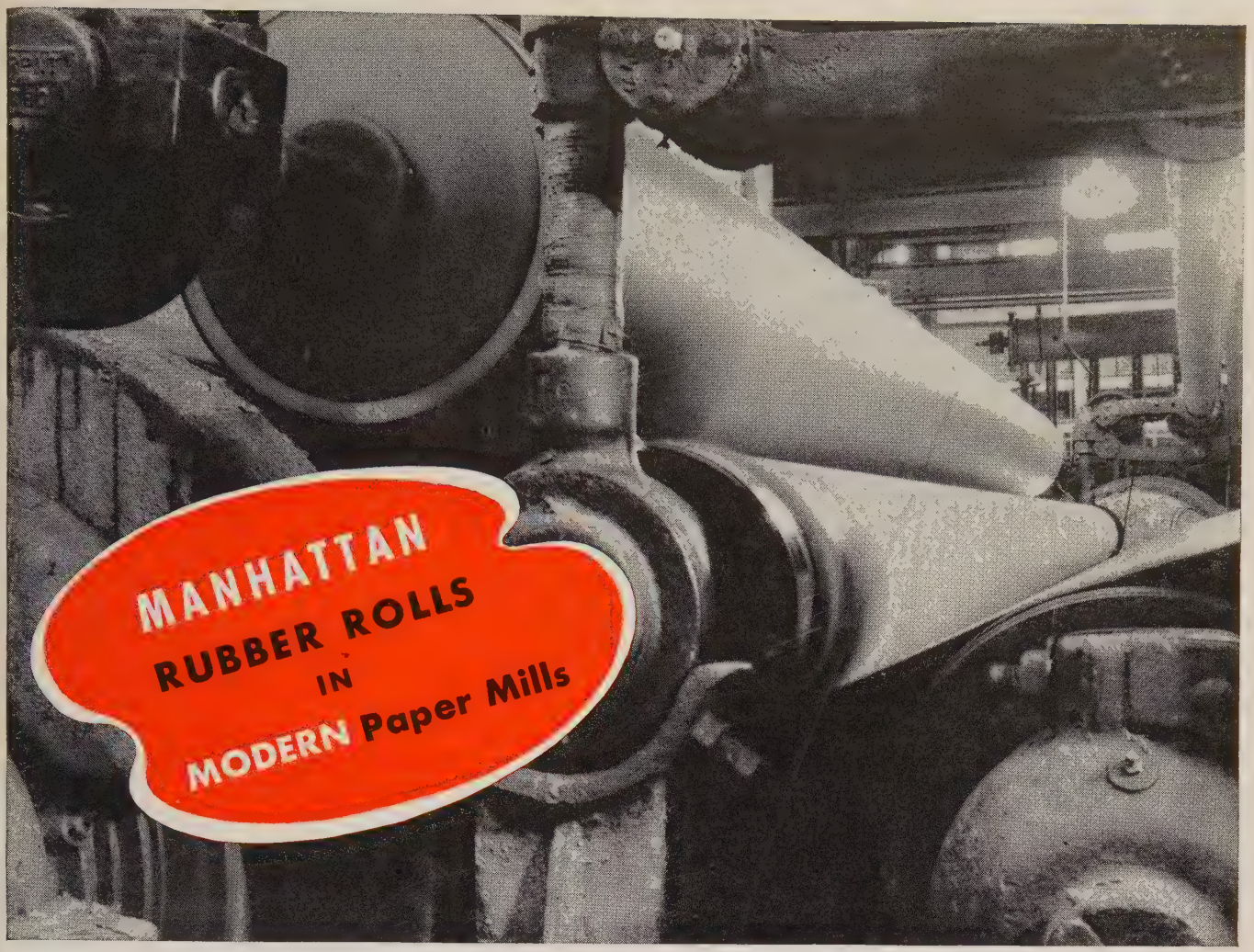

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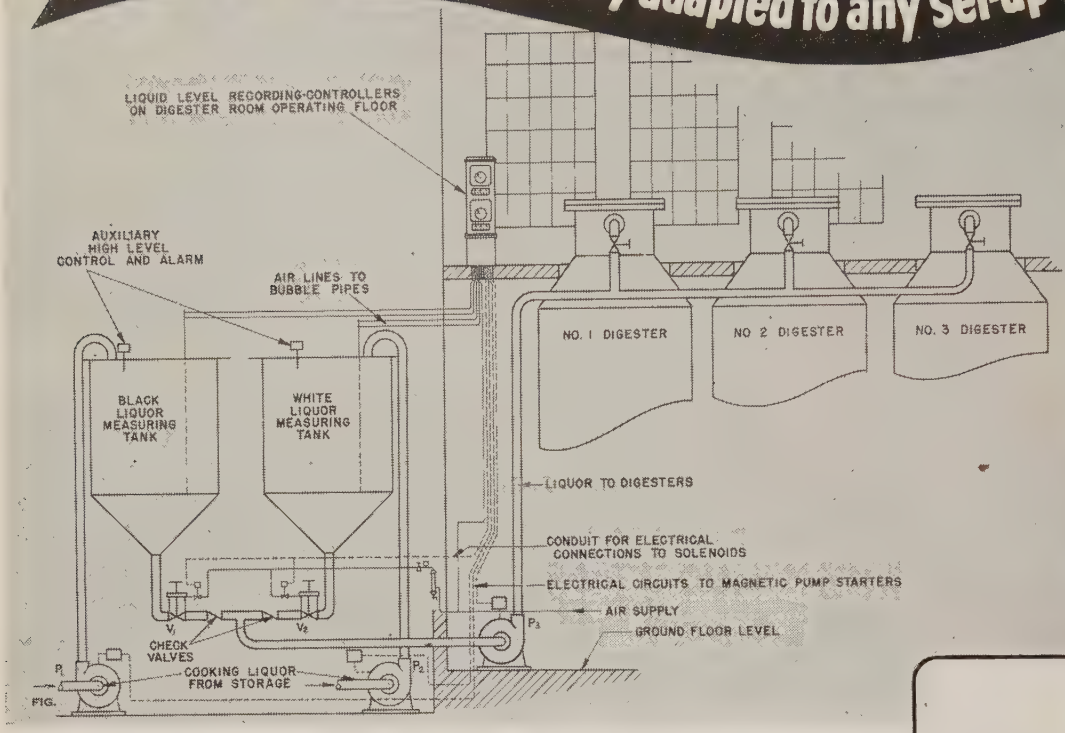

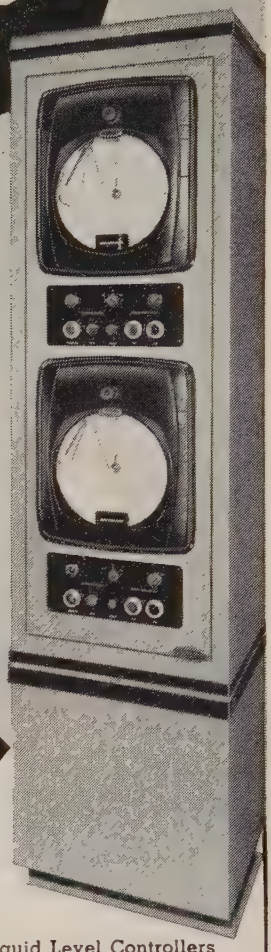

The FOXBORO Automatic Digester Liquor Measuring System

Accurate, uniform charges of liquor to digesters can be depended upon, day in and day out, year after year, when this modern packaged control system is installed. The chart gives a permanent record of the amount of liquor used; improvements in product quality and uniformity show up almost immediately.

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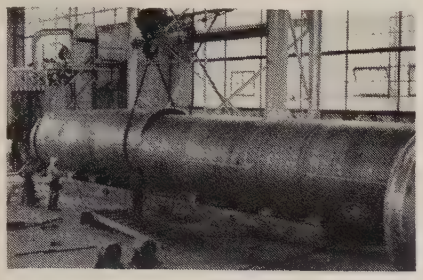
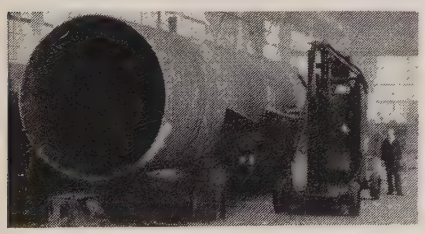
One of the plates is rolled into shape. The edges of the plate have already been prepared for welding.

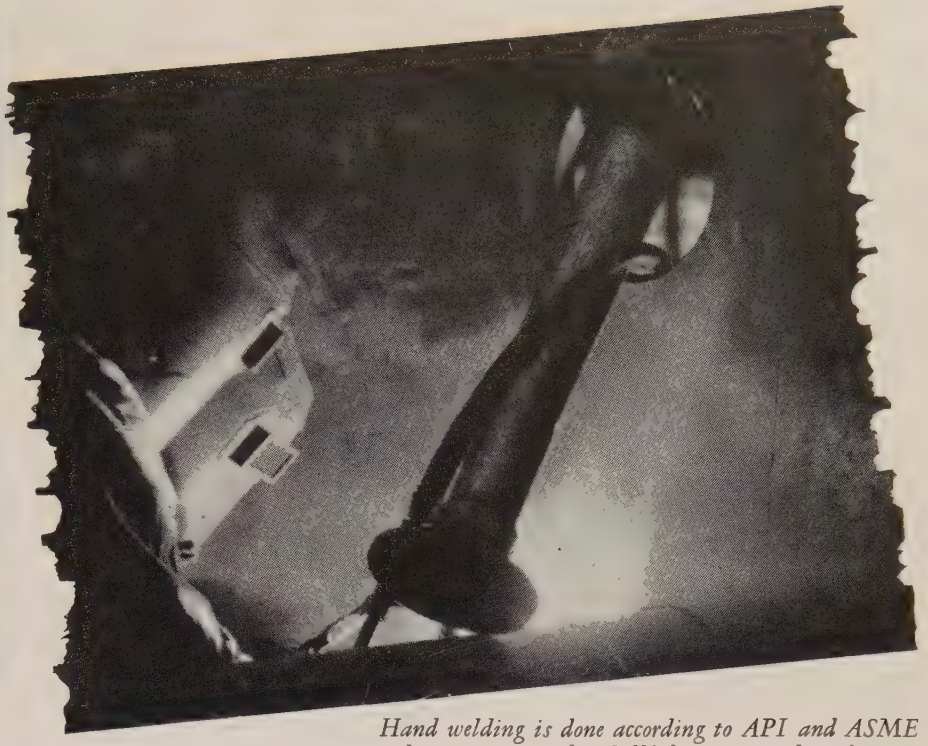


Cylindrical sections are welded together and the elliptical ends are put on. Longitudinal welding has already been done.

Automatic welder in action. Both the longitudinal and round about seams are welded automatically.



The seams of the tank are being x-rayed. In this process any cracks or flaws in the welds are detected chipped out, and re-welded.



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. . . it also takes skill, experience, and equipment—all in large amounts. Some of these extra ingredients are brought to light in the accompanying views which show the fabrication of a cylindrical pressure tank in our Chicago plant.

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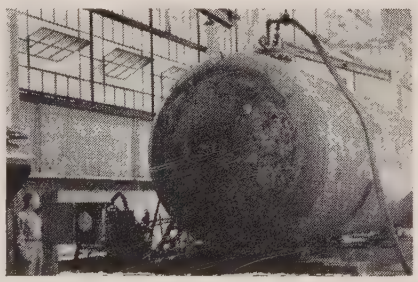

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The PRESIDENT'S PAGE

Albert E. Bachmann

Paper Manufacturing Committee

Many of our TAPPI committees, notably those of the Testing Division as well as the Acid and Alkaline Pulping, Bleaching, Coating, and Fundamental Research Committees, have over the years produced some excellent results. These committees have operated essentially on a cooperative basis as committees and have jointly surveyed almost the entire scope of their respective fields and have duly recorded their results in our literature.

On the other hand, our paper manufacturing committees have hardly scratched the surface of the vast scope of the technology allotted to them. What results have been produced in this field have been due largely to the efforts of various individuals, who have written papers on some of its isolated phases and to the various leaders, who have attempted to organize working committees in these fields. The early meetings of the old Stuff Preparation Committee and the Forming and Finishing Committee under the leadership of G. Lamont Bidwell and Fred C. Clark revolved largely around three to four totally unrelated papers in an annual session. Their principal accomplishments consisted largely of bringing to attention the new developments in the field or refiners. This was an important need of the times and did much to clarify the subject of stock preparation for us. In an effort to stimulate interest in the work of these committees under the leadership of A. E. Bachmann, Burt Kassing, O. E. Hedbring, and J. d'A Clark, and with considerable help from the representatives of our equipment manufacturers, meetings were run for a number of years in the form of round table discussions with very few, if any, formal papers. These meetings were confined to the discussion of one subject at a time. These meetings considered such subjects as Pitch Control, Cylinder Formation, Fourdrinier Formation, Stock Preparation, Freeness, Pulp Characteristics, Wet-End Water Removal on Cylinder Machines, White Water Systems, and Slime Control.

Albert E. Bachmann, President, TAPPI, Vice-President, Mississquoi Corp., Sheldon Springs, Vt.

These meetings were successful from the standpoint of large attendance, sustained interest, and the production, through vigorous discussion, of many practical ideas. They were not successful, however, in producing either a working committee or any tangible connected contributions to our literature other than the verbatim record of the discussions. The meetings by their large and sustained attendance did produce the important result of showing the interest of a large number of our members in the scope of activity of these committees. Likewise, the interest shown in answering questionnaires covered by the gamut of subjects of our TAPPI Special Reports as well as the TAPPI Data Sheets, indicates that material can be gathered on these subjects provided we organize properly to do it.

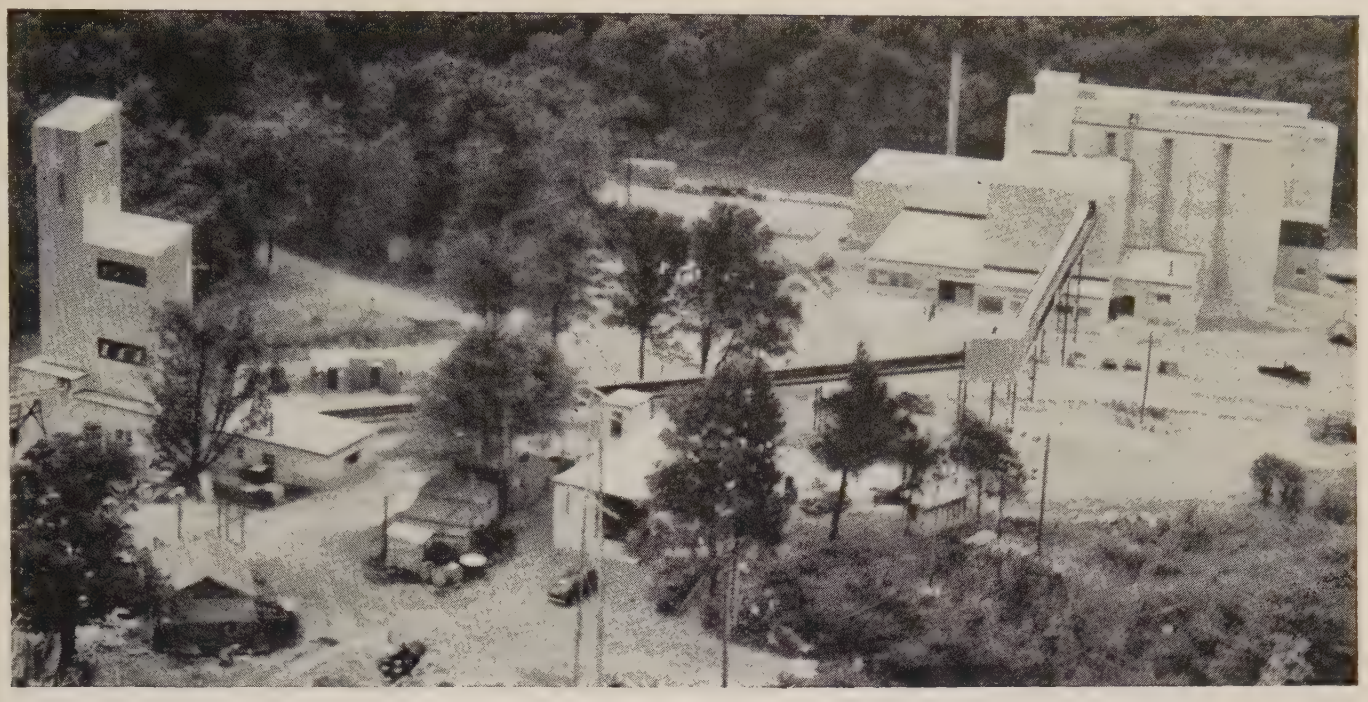
We very frequently hear paper making described as an art. According to Webster's Dictionary of Synnonyms an art is something that requires skill and a knowledge of technique and usually also requires special gifts such as inventiveness, taste, or ingenuity. The term science is applied to the gathering and classification of facts, the drawing of correct inferences from them and the establishment of verifiable general laws or principles. Even with our vastly improved mechanical controls, in the light of our present knowledge today, we cannot claim paper making to be a science yet. If any paper maker or technical man exists today who has a complete understanding of the science of paper making, he has at least escaped my notice and it has been my good fortune to have discussed its ramifications with a good many of our foremost paper makers and technical men both past and present. Are we not all, however, individually, through necessity, constantly attempting to gather and classify the facts of papermaking phenomena and combine them into the general laws of paper technology, something quite apart from our sciences of chemistry, physics, and engineering. Is not this effort the function of our Paper Manufacturing Committees?

In this effort one of our large stumbling blocks is the lack of agreement in regard to the facts themselves. How often do we hear that the same effect is not produced at other times or in other mills by similar practices because "mill conditions are different." Does not some of this disagreement with regard to the facts or phenomena resulting from certain practices result from our very incomplete knowledge of both the existence of and the methods of measurement of the fundamental variables affecting various papermaking processes?

Is it not also true that as a practical matter a complete understanding of the principles underlying some

(*continued on page 16 A*)

OUR NEW TALC PLANT



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YES! GO WEST! 1949 Fall Meeting TAPPI, Portland, Oregon

R. T. VANDERBILT CO. INC.

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(continued from page 14 A)

of our commonplace phenomena is denied us simply as the result of certain raw material or equipment rigidities with which we are unknowingly limited on a particular phase of our operations. How often, on the other hand, are we blessed with a fortuitous set of rigid or semirigid conditions, which creates no problem where others have one. A better knowledge of the principles of paper making would indeed help us solve our problems, based on these rigidities, much more quickly.

Working individually, another hurdle we must clear to make a science of a sort of paper making is the matter of time, personnel, and expense involved for extended research projects on all the basic practical and fundamental principles. All factual experience of any value results not so much from individual genius, as from the time-consuming effort intelligently applied on a specific problem in all its ramifications. This takes time and involves expense. If we can share the results of this kind of experience with others, working on different general problems, considerable time will be saved to be made available for the solution of other pressing individual problems. Again, all too frequently, it becomes necessary for us to go into action on the basis of inadequate information and, at these times, it is very comforting to get corroboration of our own ideas, independently arrived at by others with common problems to confirm our judgments on impending decisions among many variable factors on complex equipment and process problems.

All successful paper mill operators have developed as the result of their experiences certain more or less well-defined standard practices of operation as applied to their own routine, using their own equipment and materials. These standard practices usually include standard methods of coping with the usual troubles and difficulties which ordinarily occur. Conformation to the existing and slightly modified standard practice usually results in efficient operation based on past standards of efficiency in their own mill. For operators who are engaged in the manufacture of many grades or specialities, knowledge of fundamental principles beyond their standard practice routine is vitally necessary. Also, when we are forced to move in the direction of increased speeds, extra capacities, and improved qualities or when we try to introduce certain elements of cost reduction, involving substitution of materials or savings of stock, heat, power, steam, and chemicals, it again becomes more necessary for us to acquire a better concept of the principles of paper making than can be developed through experience by absorption.

Many of the principles that we claim to know, until we start to write them down, are at least somewhat nebulous. This is not strange when we consider that much of our so-called experience capable of being drawn upon for new or unusual phases consists of a rather vague memory of a particular result attending a certain cause without being too sure regarding all other conditions prevailing at the time. Even if we have established as a routine the practice of definitely recording all items of experience in terms of all pertinent data and results as they occur, we will still be handicapped by lack of time, as well as our equipment and material rigidities in our efforts to obtain a complete set of working principles. As individuals or as groups in individual mills we too often, even in the presence of a formal system of recording of our experience to correct unusual troubles or to produce unusual results, draw on our experience for four or five effects, which we feel will at least work in the right direction. We use them more or less simultaneously because in paper mill operation time is vital and production cannot too often be carried out by research techniques of examining one variable at a time, even if the others could be controlled.

Under such circumstances, which are not unusual, we can safely state that most papermaking principles, such as we possess, must be regarded with some degree of suspicion, regarding their validity, particularly when used under slightly different circumstances. We must indeed bear in mind the definition that after all "Truth is something which temporarily has the appearance of permanence." If this applies in philosophy it certainly applies equally well in a field of complex and interrelated variables, such as paper making.

It would seem helpful if through joint cooperative endeavor we could write up the true principles of paper making in the sense of the above definition with such proofs as we could muster at the time. It would help our research men if they knew more positively what the facts or results were that corresponded to definite conditions that might cause them. They might be able to evolve satisfactory hypotheses or explanations to help us arrive at definite principles more rapidly. It would be interesting to have some principles dealing with all phases of a single subject, which we knew to be the outpost of our combined present knowledge. If it did nothing else it would rapidly permit our research men to get abreast of existing developments and put in their time advancing from the outposts instead of replowing ground covered by a host of investigators who never got far enough to publish their incomplete and restricted results.

In some cases, due to complexities of variables, it might even be advisable to write combined principles based possibly on sketchy data, which could be refined by constructive criticism to the point where they would hold water and temporarily have the appearance of permanence, until our knowledge advanced further. This is merely the standard practice method which we all use in our operations where standard practice represents the best way we, within our own organizations, know about doing things at the time. Standard practice, as every one knows, is a constantly changing and improving procedure. In the development of any kind of standards whether quality, production, cost or standard practice, we invariably find that the larger half of the job is done when we once get our existing knowledge refined by group discussion and written down. It is much easier to continuously correct and improve something that exists than to wait for perfection before writing anything down. Such methods might be frowned upon by strictly scientific standards but they would get practical results. Much of the thought of this article has been gleaned from correspondence files on this subject dating back to August, 1939. Had we cooperated collectively in this manner for the past ten

(continued on page 18 A)

balance: an equality of weight, power advantage

Substantially built from bed plate up, Langston Slitters and Roll Winders provide the balanced power that produces highest quality rolls.
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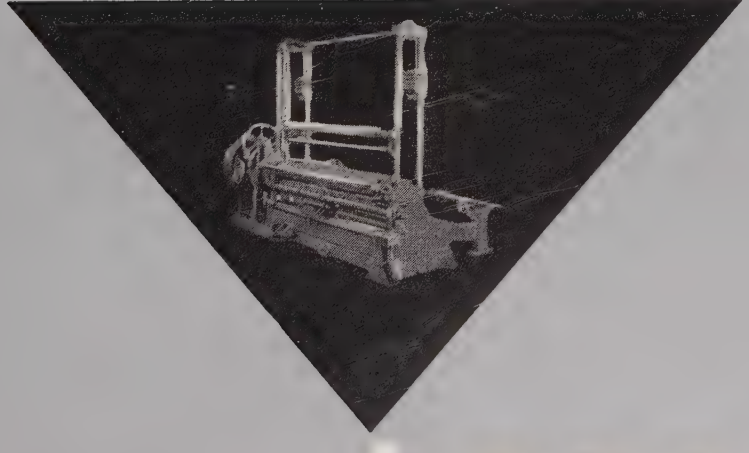


Langston

SLITTERS AND ROLL WINDERS

(*continued from page 16 A*)

years we would be much further ahead today. As a matter of fact, is not the procedure described here simply a duplication of the methods used in the establishment of our present standard testing methods? We would rate some of our earlier adopted testing methods as being very crude compared with their present-day counterparts, which were slowly evolved over the years by cooperative criticism and study.

To resolve some of these generalities to a specific basis for action we need to organize a type of program and method of procedure which will result in more cooperative and collective effort and release the individual of the entire responsibility for his opinions and beliefs resulting from fragmentary data, by arranging for proper corroboration and sharing both the responsibility and authority with a group.

Under the respective chairmen of the Cylinder and Fourdrinier Papermaking Committees we need to form a general committee composed of chairmen of all the various grade-group sub-committees and chairmen of such additional functional committees of specialists as it may be deemed necessary to form. Grade-group and functional sub-committees should be formed composed of 10 to 20 or more members.

Obviously, as a result of its fundamental importance and to provide an outlet for participation of the large number of our present and future members concerned with operating, TAPPI should very definitely have several active papermaking committees comprised of as many as 100–200 people. There is a distinct need for TAPPI to become more active in this field and there is a distinct need for our members to cooperate and collaborate in this work for the benefit of themselves and their companies. The people we need on these committees are busy people and obviously the program of activity should be arranged to use a minimum of their time but we feel sure that any time put into the activity of the Paper Manufacturing Committees will be more than repaid to the individual even if no other benefit resulted than the fact that meeting deadlines impelled him to work at the particular subject. I can speak with experience on this subject.

The Paper Manufacturing Committee chairmen are James J. Harrison, of Michigan Carton Co., in charge of the Cylinder Machine Committee and Noel R. Phillips, of Champion Paper & Fibre Co., in charge of the Fourdrinier Committee. They would welcome volunteers to serve on the various sub-committees of their respective groups. Some of you may even receive appointments to these committees which they sincerely hope you will accept. The authority that this work will carry depends largely on the number and caliber of the people taking part in it.

In brief the objectives and method of operation of the various sub-committees would be somewhat along the following lines:

The primary object of the work of these committees should be to furnish the members of the Association with ideas which will be helpful to them in their daily work of controlling or improving production quality and reducing costs, particularly with reference to the phases on which cooperative working is practical, from the standpoint of normal competition.

A further objective should be to duplicate the results of the various TAPPI testing committees in establishing published results of their work in the form of properly coordinated principles bearing as much authority as the combined experience of the committees and their consultants can give it in the field of technical papermaking.

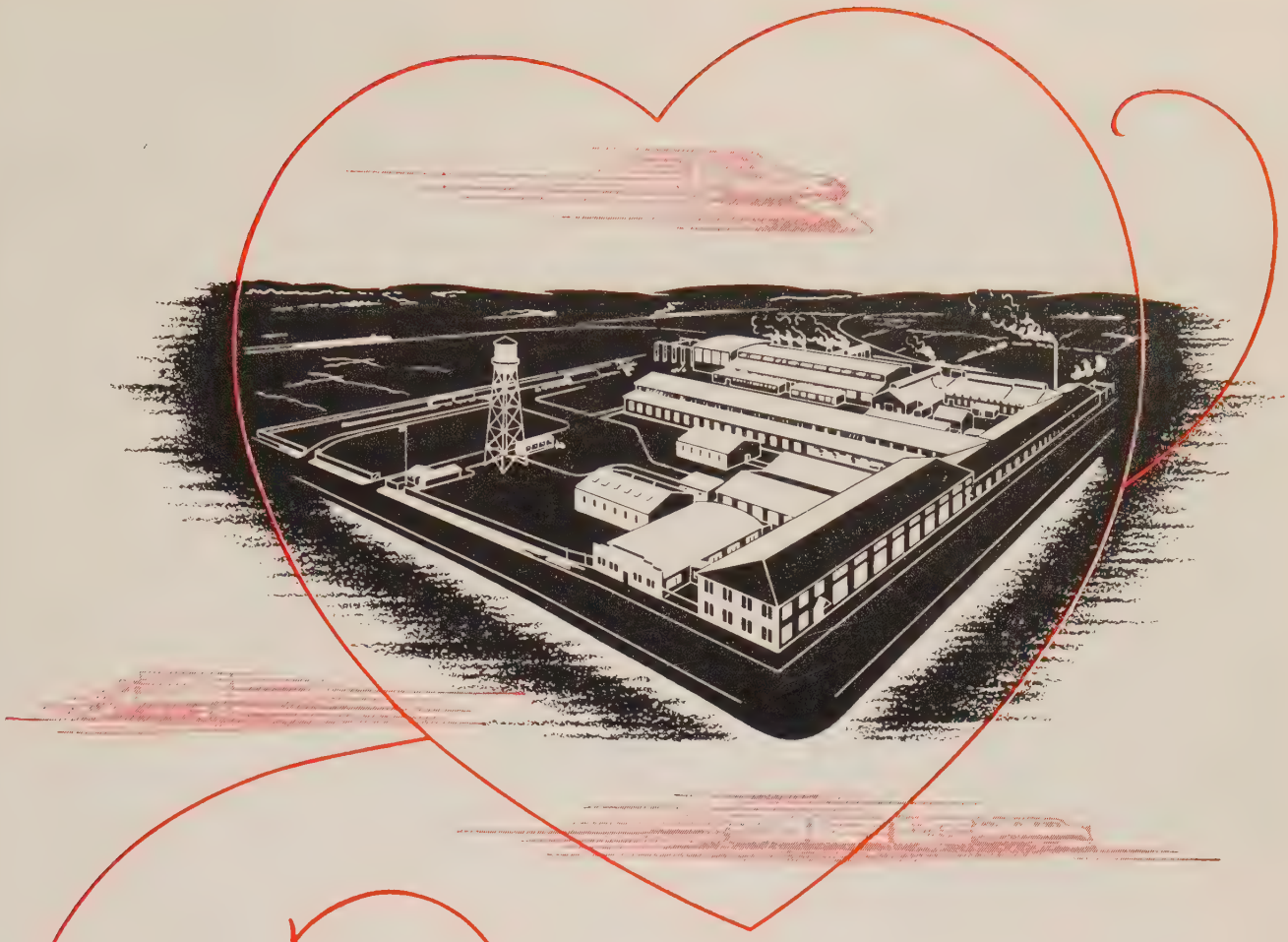
It should be the purpose of these committees to explore by questionnaires, simple mill tests, group papers, informal unpublished or formal individual papers, round table discussions, and eventually by research in cases of nonagreement, one subject until enough corroboration is attained by these various methods to dignify the conclusions as tentative principles suitable for publication with supporting data.

The work of the committees would be directed primarily toward the development of principles regarding how to produce and test for specific properties or combinations of properties of pulps and papers and how to overcome specific common difficulties rather than directed toward the standardization of individual grades. What the activity really contemplates is the joint study of papermaking equipment and processes to the end that if agreed-upon principles cannot be established at least the research can be directed toward the points of greatest interest and upon which the industry is most confused. Such an objective would ultimately lead toward both the improvement of the individual and the best interests of their companies, which after all is the object of any collective association endeavor.

With a modest amount of work from many individuals we can start to gather the facts, classify them, and try to arrive at general laws or principles. The material is now largely in our hands collectively, no one person or no organization possesses it all or any great part alone, but by working with cooperative effort in groups of common interest under our Paper Manufacturing Committees, suitably subdivided, we could in a relatively short time accomplish much of value and at the same time provide an outlet for participation to at least a minor degree of a large part of our membership.

We have arranged to hold this Fall, in connection with the Fourth Engineering Conference, a single meeting each of the Cylinder and Fourdrinier Committees, as a start toward an annual topical-type papermaking meeting sponsored by these committees. We hope by the caliber of such meetings to merit the support of our many management and corporate members to the extent that they will encourage their men to take a more active part in this vital activity as part of their necessary educational training.

Ed. Note: The aforegoing message from our President, Albert E. Bachmann, is an excellent statement of one of the great technical problems facing the industry. Mr. Bachmann has given much thought to this subject. To attain the ends desired requires a *modus operandi*. This is provided, at present, by our two Papermaking Committees. These committees should serve as a nucleus for the establishment of a number of sub-committees to deal with the various aspects of the problem. Because of its empirical nature the problem is not a simple one. Everyone concerned should give the matter much thought. Why not send your comments to the Association Secretary. All such contributions will be good "grist for the mill."



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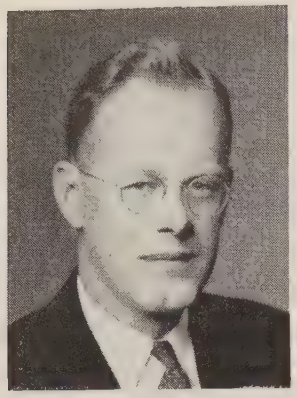
Long-Term Outlook for Wood Pulp*



James L. Ritchie
(U. S. Pulp Producers Assoc.)

The Search for Fiber

Throughout most of the nineteenth century, shortages of fiber blighted the growth of the world's paper industries. The search for an abundant fiber suitable for papermaking ended late in the century with the development of wood pulp. By 1900 the use of wood pulp in U. S. paper manufacture exceeded the use of all other fiber. Wood had proved itself the most economical source of cellulose for papermaking. Its position has never since been challenged. Wood currently constitutes over 93% of the volume of fibrous raw material used in domestic paper and paperboard production.

Though the search for new and better fibers is never ceasing, it is doubtful that research in our time will discover a fiber better adapted than wood for the production of low-cost quality papers.

Broadening the Species' Base

Spruce and hemlock were the species found to be ideally suited for the production of sulphite pulp in the early years of the industry's history. The U. S. paper industry, in the first two decades of the twentieth century, reached across the northern part of the United States as it sought out suitable spruce and hemlock stands to support its growth and development.

Fear that remaining domestic stands of spruce and hemlock, already depleted by the lumber industry, might prove inadequate to support our national requirements for pulp and paper production led to tariff action in 1913. Wood pulp and newsprint were placed on the free list, ostensibly as a conservation measure designed to open the gates for the products of Canadian spruce and hemlock and to preserve our own wood supply to support the production of our existing domestic industry. From that point on, the measure of our dependence upon imports began to grow. Pulp and paper, as a consequence, are today our most important single import item.

The dynamic nature of our domestic pulp and paper industry, however, was not to be gainsaid. Confronted once again with the threat of local fiber shortages, the search for more abundant papermaking fibers than spruce and hemlock was vigorously renewed.

The growth of the domestic wood pulp industry in the intervening period is the best evidence of the success of this search. Today, as a result of relentless experimentation, there is scarcely a species of wood that cannot, by one pulping process or another, be converted to pulp suitable for papermaking. The knowledge that has been acquired in regard to the use of new pulping species is a reserve force that can help propel the pulp and paper industry to new production heights, over the long-term future, as our national requirements mount.

Pulping Processes

The development of new pulping processes has helped to make possible this broadening of the species' base.

Soda, groundwood, and sulphite were the original processes employed in the manufacture of wood pulp. In the period 1939–1949 inclusive, groundwood capacity will have increased by 21%, sulphite capacity by 12%, and soda capacity will have decreased by 16%. Since these processes are still largely dependent upon conventional pulping species, their future growth will be perhaps less spectacular than that of the newer pulping processes.

In recent years there have been new and important adaptations of these older pulping processes. Recent developments in the manufacture of bleached groundwood, for example, will result in improved fiber utilization, more economical production, cheaper yet better products, and broader markets.

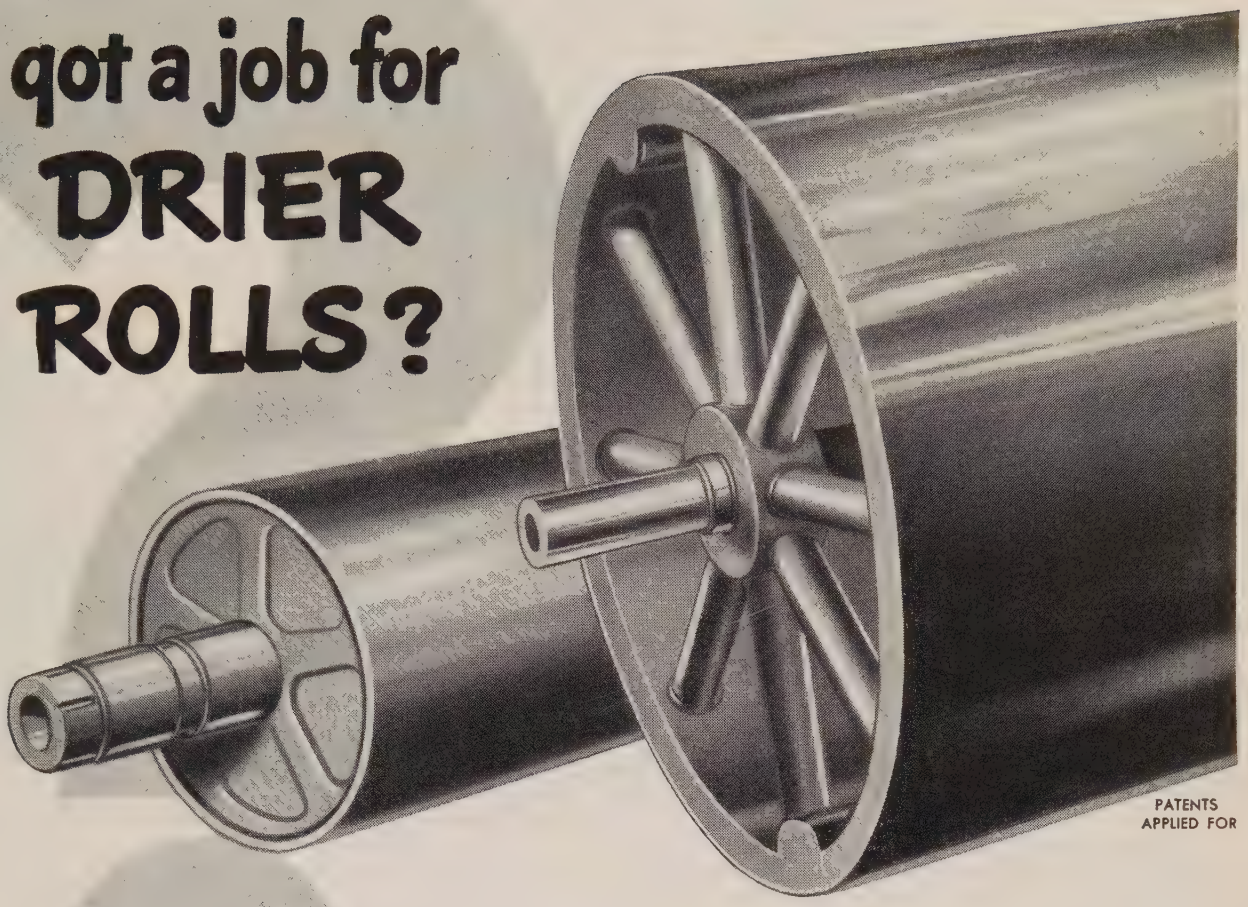
Improvements in the sulphite process have made possible the production of dissolving pulps, domestic production of which has increased by 165% since 1939. This development opened up new and diversified market outlets for the wood pulp industry—rayon, cellophane, plastics, explosives, paints and lacquers, etc. Demands for dissolving pulps should have a spectacular long-term growth as its dependent infant industries grow to maturity. Announced plans for the production of domestic dissolving pulps by the kraft process, when consummated, will broaden the range of wood species used for this purpose.

It was the development of the kraft process, however, that really opened the door to a more abundant pulpwood supply. In 1928 17% of this country's total wood pulp production was manufactured by the

(continued on page 22 A)

* An address given at the meeting of the TAPPI Delaware Valley Section, Engineers Club, Philadelphia, Pa., May 26, 1949.

got a job for DRIER ROLLS?



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Whether your job calls for rolls alone, an addition to present equipment or a complete new machine, Lukenweld engineers are prepared to engineer and build it for you. For such help, or for Bulletin 358 on Lukenweld Rolls, write Lukenweld, Division of Lukens Steel Company, 501 Lukens Building, Coatesville, Pennsylvania.

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(continued from page 20 A)

kraft process, in 1938 41%, and in 1948 47%. Domestic capacity for the production of kraft pulp will have increased by 3,839,406 tons, or 104%, in the period from 1939 through 1950. The sulphate process was a phenomenal development not only because it made possible the utilization of a vast new species but also because it opened up a vast new type of market to the paper and board industry. For both of these reasons, its long-term future should be bright.

Even more recently, new high-yield pulping processes designed to provide an increased fiber utilization have had a most spectacular development. These new processes include defibrated and exploded pulps, semichemical, and chemipulps. Capacity for the production of these grades in 1950 will total 2,087,930 tons, an increase since 1939 of 677%.

These new high-yield pulping processes are no respecters of species. Almost any kind of wood in almost any condition is acceptable. These processes lend themselves admirably to the utilization of wood wastes from other forest product industries or to the use of limited local wood harvests, regardless of species.

Further, the capital investment required for the construction of plant facilities employing these special processes is far less than in the case of facilities designed for conventional pulping processes. Small unit operations are feasible because of the type of equipment required. Production can be, and normally is, carried through several stages of conversion right on the mill premises. The value added by manufacture to a normally low-cost raw material can be very substantial.

These high-yield processes accordingly offer great opportunities both for small unit operations located near markets that can absorb the manufactured end product, and for economical supplementary production designed to extend wood values and end product values for large-scale forest product industries.

The long-term growth of pulp production by these special high-yield pulping processes may well be phenomenal. They will afford a means for further pulp and paper expansion on a local but, in the aggregate, important scale long after the nation's forests appear to be supporting their maximum production of forest products.

World Wood Pulp Supply

Excluding Russia, world production of wood pulp in 1948, according to information developed at the recent Montreal Conference of the Food and Agriculture Organization, was distributed approximately as follows:

North America	69%
Europe	28%
Asia	2%
U.S.S.R.	N.A.
Latin America	—
Africa	—
Near East	—
Oceania	—
	100%

* N. A. = not available
† — = less than 1%

The long-term outlook for wood pulp in each of these areas will depend first upon the availability of suitable wood supplies, second upon the accessibility of markets, and third upon the availability of economic and technical resources for industrial development.

It is reasonably certain that wood pulp, over the long-term, will continue to be produced where forest resources are located, since experience has proved that it is uneconomic to transport pulpwood in volume over great distances. Quite apart from this consideration, however, those countries that possess abundant forest resources are intent upon developing them for their own economic advantage; consequently, even short haul international movements of pulpwood are likely to dwindle as nations fortunate enough to own substantial forest resources reserve them for the development of their own forest product industries.

It is significant that no important wood pulp industry has yet developed in an area far removed from prosperous consuming markets. The development of forest areas remote from the centers of civilization can only come when world shortages of wood pulp reach such proportions as to make their use economically practicable.

Large-scale production of pulp and paper requires heavy capital investments and great technical skill. Pulp and paper are the products of economic and human resources as well as of forest resources, and only where these are available can large-scale industrial development reasonably be expected.

Pulp and paper production will flourish best over the long-term future, as it has in the past, where these three elements are most favorably combined.

North American Outlook

The best possible combination of abundant forest resources, market accessibility, economic power and technical know-how, is to be found in North America. It is because of this that North America is currently producing 69% of the world's total wood pulp supply, exclusive of Russian production.

United States—Pulpwood consumption in the United States in 1948 totaled 21,189,458 cords, the highest annual consumption on record. Of total receipts, 90% was of domestic origin and 10% imported from Canada.

The volume of pulpwood cut in the United States in 1947 was equal to 13.3% of the total United States forest cut. In 1936, pulpwood constituted only 6.2% of the total United States forest cut. The relative importance of wood pulp as a forest product industry has, accordingly, increased materially in recent years.

Despite this increase the United States wood pulp industry is consuming a relatively smaller share of total wood cut than the pulp industries of most of the other major pulp producing countries of the world. In Canada, for example, pulpwood in 1947 constituted 33% of the total forest cut, and in Sweden 24.7%.

To the extent that the United States pulp industry's share of the total forest cut may be increased over the long-term future, by so much will its opportunities for further development and expansion be improved. There is every indication that the economic incentives for such a diversion of wood supply, in the years ahead, will be great.

(continued on page 24 A)

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The excellent film properties of water-soluble Methocel, including toughness, flexibility, clarity, oil and wax resistance, and high binding power have proved particularly useful in a broad range of paper sizing applications.

Methocel may be just what you have been looking for to improve your product. Send in the coupon for your *free* experimental sample of the *new* Methocel, *powdered*. Try it and see the many superior advantages of Methocel.

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CHEMICALS INDISPENSABLE
TO INDUSTRY AND AGRICULTURE

(continued from page 22 A)

The volume of wood available for United States pulp production in the long-term future can be still further increased by more intensive forest conservation measures. Waste will be reduced and economies affected by a long-term trend toward the integration of forest product industries. Economic factors will encourage a long-term trend toward more effective forest management, with consequent increases in the volume of pulpwood potentially available. Extensive reforestation will expand the productive acreage and improve the growth rate. More effective control of fire, insects and disease, which now consume annually as much wood as is consumed by the pulp industry, will further augment the available wood supply. Timber lands now classified as "inaccessible" will become accessible, further broadening the range of commercial forest lands.

More effective utilization of the industry's wood supply can still further improve its future production potentialities. Wood conservation can be practiced in the mill as well as in the forest. Not only through new high-yield pulping processes but through new mechanical devices, such as the hydraulic barker and the whole log chipper, notable economies in the utilization of pulpwood have been effected. The economic incentives for further development work along this line will be great.

Effective conservation in the woods and efficient utilization in the forest product industries will insure a wood supply adequate to support a continued long-term growth of the domestic wood pulp industry. The U. S. Forest Service has estimated that domestic production of pulpwood, by the end of the century, can exceed 1947 pulpwood production by 176%. If this forecast of the U. S. Forest Service in regard to the future availability of pulpwood resources is correct, economic and technical resources should certainly not be lacking to insure continued steady growth of the domestic wood pulp industry.

Canada—The long-term outlook for Canada is also favorable.

Economic and technical resources are available for the expansion and development of Canada's industries, and the vast U. S. market is at her gate. Canada's forest resources will support further long-range growth of her forest industries. Her forest experts predict that, with more intensive forest management and with the opening up of nearly 247 million acres of productive forest now classified as inaccessible, "Canada will eventually be able to sustain in perpetuity an annual output of forest products of more than double the present volume."

Alaska—It has been estimated that Alaskan forests, properly developed and managed, will support, in perpetuity, a wood pulp industry capable of producing at least 900,000 tons of wood pulp annually.

Economic and technical resources will, of course, be available for the development of an Alaskan industry whenever it becomes apparent that distant markets can economically absorb this tonnage.

Outlook for Europe

Europe's long-term problem will be one of wood supply.

Europe's forests were heavily overcut during the war. Forest cut is currently exceeding net growth in Europe by 20%. Despite overcutting, pulpwood supplies in Europe continue inadequate to insure full operation of Europe's existing wood pulp facilities. For full operation of its existing plant facilities, Europe would require 58% more pulpwood then she consumed in 1947.

Prewar, Europe imported about 1.7 million cords of pulpwood, solid volume, without bark, from Russia and her satellite countries. Imports from this source are no longer available, and prospects of a revival of this trade are poor. Substitute sources are not available.

Nor is there much chance that Europe's wood supply can be materially increased through improved forest practices, integration, or more careful utilization. Europe's forest industries, and particularly those of Finland, Norway, and Sweden, which have 77% of Europe's productive capacity, are already highly developed along these lines. The chief hope for improvement would appear to lie in a further diversion of wood from other uses.

In fact, present conditions in Europe appear to justify fully the conclusion that the wood pulp industry of western and northern Europe is seriously overbuilt. There is slight prospect that European wood supplies, even for the long-term future, will be adequate to permit full operation of productive facilities now in existence. Expansion of Europe's over-all pulp capacity, based on the present outlook for wood supply, appears most unlikely.

In view of prospective long-term European wood shortage, questions of economic resources, market outlets, and in fact all other considerations become entirely academic.

Outlook for Russia

The "continuous" forest area of Russia totals approximately 1730 million acres, as compared with a productive forest area of 1127 million acres in all of North America.

The balance of species in Russia is comparable to that of the other forested areas of the Northern Hemisphere. Her reserve supply of recognized pulpmaking species is, therefore, by far the greatest in the world. Based on prospective availability of wood supply alone, the potentialities of Russia as a producer of pulp and paper are almost unlimited.

Russia's per capita consumption of pulp and paper has in the past been extremely low. Social improvements among her vast populations could, over the years, result in the creation of a vast new consuming market that might well afford a ready outlet for a far greater pulp and paper production. If Russian consumption fails to keep pace with the expansion of Russia's productive facilities, Russia could conceivably at some stage become an important factor in international trade in pulp and paper.

Whether or not Russia has the economic and technical resources to expand her economy and set in motion an early development of her forest product industries are moot questions. In the absence of information about her internal economy, it is virtually

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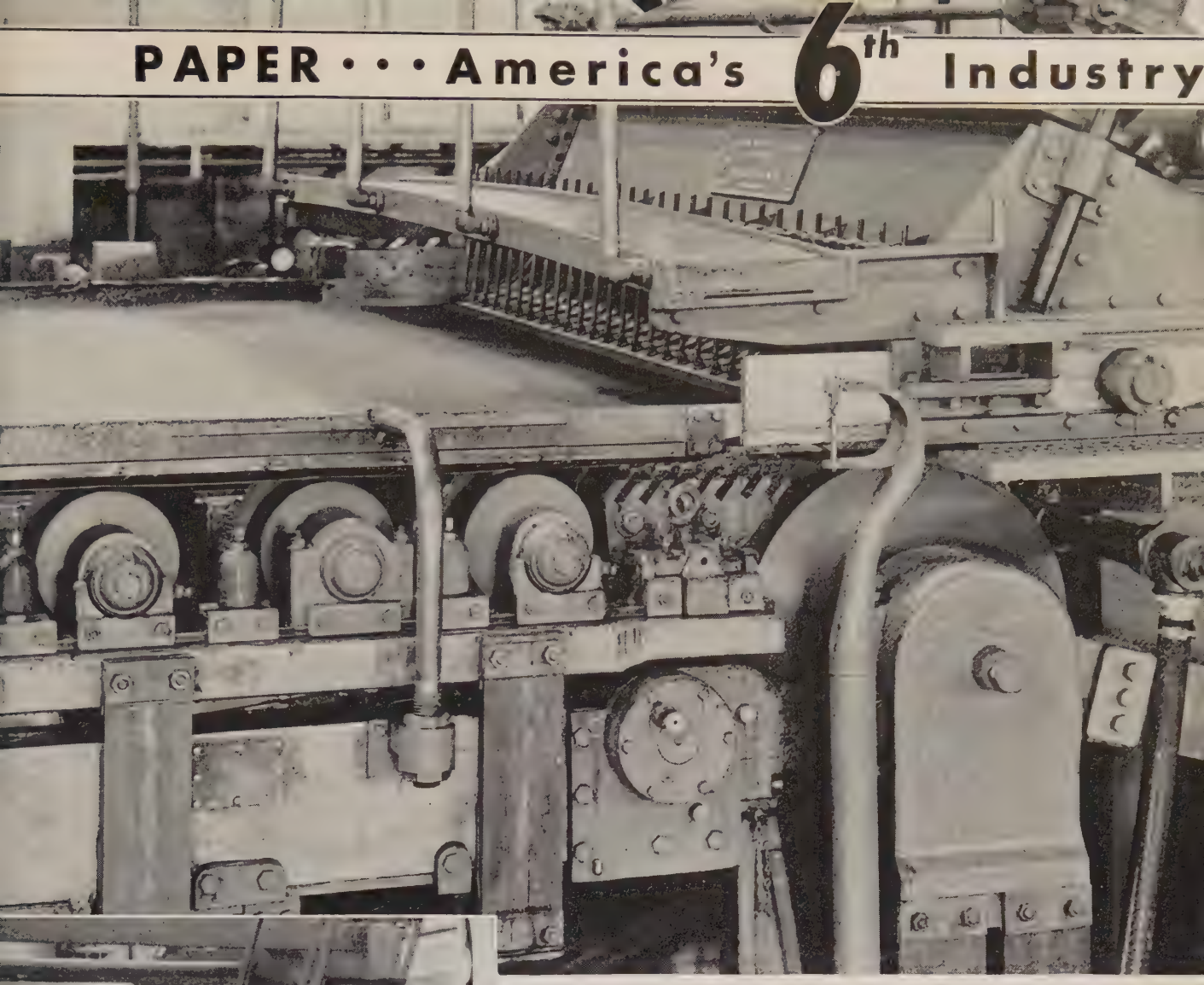
PAPER · · · America's 6th Industry



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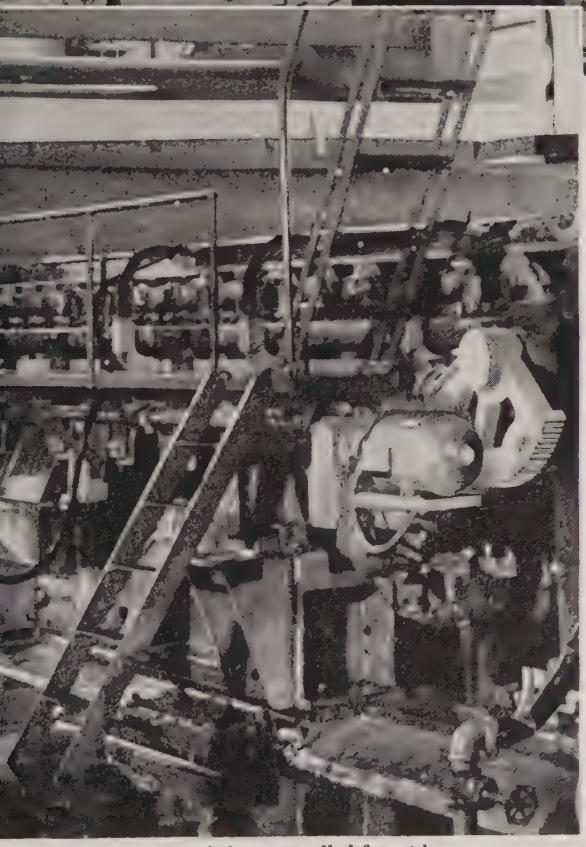


Old conventional breast roll lift with cumbersome, *exposed* motor operated gearing.

Now the Breast Roll Lifts Hydraulically

Here is one of the latest operating advantages of Puseyjones Machines. The breast roll is now raised and lowered from operating position by hydraulic mechanism totally enclosed in the side frames, replacing the conventional exposed gearing and motor. Check these important advantages:

(1) Eliminates danger of breakage

(2) Reduces maintenance cost

(3) More efficient wire changing

(4) Greater accessibility for operators

This new hydraulic breast roll lift is just one of the many design improvements in the new Puseyjones Machines, improvements that mean higher speeds, lower production costs and improved competitive position. Let us give you the facts.

THE PUSEY AND JONES CORPORATION

Established 1848. Builders of Paper-Making Machinery

Wilmington 99, Delaware, U.S.A.

THE SIGN OF TRADE MARK SUPERIOR QUALITY

YES! GO WEST! 1949 Fall Meeting TAPPI, Portland, Ore.

(continued from page 24A)

impossible to predict to what extent and how soon her industrial potentialities may be realized.

Outlook for Southern Hemisphere

There are approximately 1767 million acres of productive forest land in South America, and an additional 741 million acres in Africa.

In both of these regions, however, the forests are almost entirely tropical, and the species extremely heterogeneous in character. Technology is still a long way from solving the complex problem of cooking, with satisfactory results, assorted species of tropical woods. If and when this problem is satisfactorily resolved, there will remain the even more difficult problem of combating jungle diseases and establishing stable and lasting jungle civilizations.

New Zealand has met with some success in reforesting tropical areas with a single species of fast-growing tropical wood. Other regions in the Southern Hemisphere are experimenting along this line.

The fast-growing tropical woods constitute a vast, but as yet valueless, last reserve of forest resources. For technical, economic, and social reasons, it will probably be a long time before there is any very extensive use of these great forest areas.

Outlook for Asia and the Far East

Japan is the only important center of pulp production in Asia and the Far East. Production within the present borders of Japan totaled 450,000 short tons in 1948 compared with 850,000 short tons in 1941.

Like Continental Europe, Japan is short of wood. Her present demands for wood are equal to twice her annual growth. There is no apparent source to which she can look for pulpwood imports.

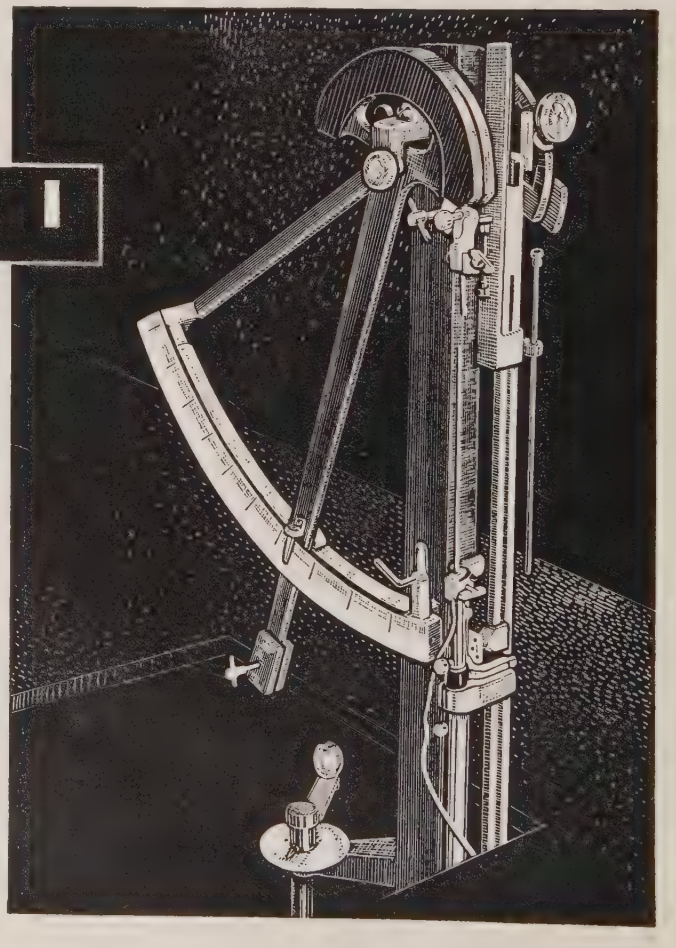
Reforestation and substitute fibers are her only long-term hopes. Meanwhile her wood supplies will be inadequate to support anything like capacity operation of even her existing facilities. There is no prospect of any over-all expansion of production in Japan.

No significant pulp developments are expected in any of the other countries of Asia or the Far East.

World Wood Pulp Demand

Growth of the wood pulp industry, apart from the population factor and the short-term cyclical factor, will continue to depend upon the ability of its technical group to develop new products to absorb and expanding wood pulp output.

Wood pulp, over the long-term, will be consumed only to the extent to which it can be converted into products for which an economic demand can be created. Fantastic estimates of future wood pulp requirements have been made on the assumption that U. S. per capita consumption may some day become the standard of the world. Such a basis of calculation is entirely unrealistic. Economic capacity to consume, not sociological requirements, will determine the local level of consumption of wood pulp and its products in the long-term future as it has in the past.



control

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Each strand of wire produced by Appleton is carefully tested for tensile strength and elasticity. To pass these tests, Appleton Wires must be Good Wires.

APPLETON WIRE WORKS, INC.
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Outstanding for

WALL PAPER

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BEATER DYEING

DU PONT

PIGMENTS

FOR QUALITY PRODUCTION

Chrome Yellow
Organic Yellow Lakes
Molybdate Orange
Soluble Blue
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full strength and lakes
Dispersible "Monastral"
Blue and Green Lakes
PTMA
Blue, Green and Red Lakes
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DU PONT

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BETTER THINGS FOR BETTER LIVING

. . . THROUGH CHEMISTRY

Standardized Pigments to meet the exacting requirements for paper coloring.

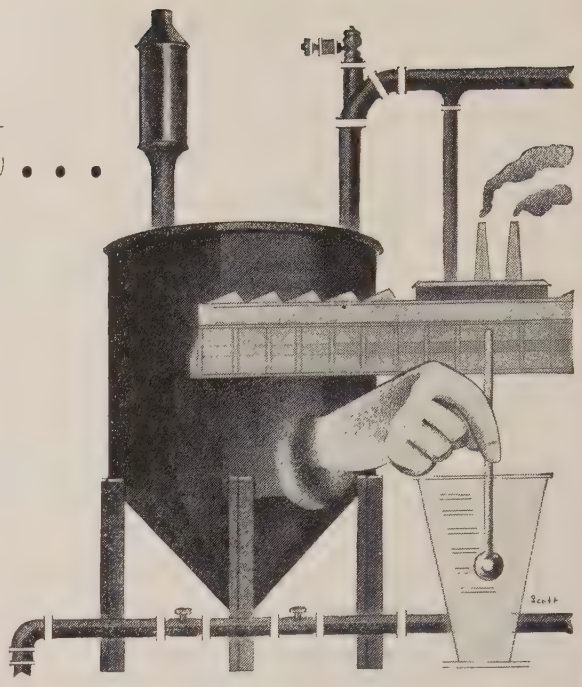
The Du Pont line includes economical pigments as well as those of highest quality. There are colors for beater dyeing which have been especially processed for quick and thorough dispersion in water. They have better strength than the usual lakes for beater coloring. Use them for papers which must have good lightfastness.

All Du Pont pigments are standardized for properties important to their use in paper. They may be adapted to the most exacting requirements Du Pont Pigments Laboratories and Technical Service are ready to help you in the use and application of any of these pigments, to help you work out specific coloring formulations for maximum effectiveness and savings.

You can get further information from your Du Pont salesman, or by writing to E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, 1007 Market Street, Wilmington 98, Delaware.

• Tune in to Du Pont "Cavalcade of America, Monday Nights—NBC coast to coast

Craftsmanship in Bleaching Kraft...



During the years immediately following 1934, the pulp and paper industry gave considerable attention to the bleaching of kraft. Hooker technical men continued their cooperation with the industry by carrying out intensive research to learn more about the chemistry of bleaching kraft and to develop better detail of operations.

Out of this cooperative study there came many contributions to a better understanding of kraft bleaching and to better operational procedure. Much of this information resulting from Hooker research is still available in the form of reports and bulletins. Among them are the following:

Bulletin 211
Chemistry of Bleaching Chemical Wood Pulps

Bulletin 212
Bleaching Kraft

Bulletin 214
What Do We Know About Bleaching

Bulletin 236
Importance of pH and Catalysts in Bleaching Operations

Bulletin 241
Bleaching Gumwood Sulfate Pulp

Bulletin 243
Procedures and Brightness Grades in Bleaching Sulfate Pulps

The value of these publications is attested to by the hundreds of them that have been and still are being distributed. Much of the information in them is still pertinent to present day procedures. We suggest you send for any of those you do not have.

Another valuable way in which Hooker is helping the industry is in supplying consistently high quality chlorine, caustic soda and in rendering service that means uninterrupted production for you.

HOOKER CHEMICALS

HOOKER ELECTROCHEMICAL COMPANY
4704 BUFFALO AVENUE • NIAGARA FALLS, N. Y.
New York, N. Y. • Wilmington, Calif. • Tacoma, Wash.

7-378 Caustic Soda Muriatic Acid Sodium Sulfide Paradichlorobenzene Chlorine Sodium Sulfhydrate

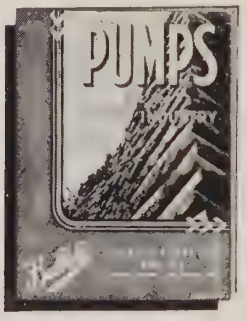
No Stock "Bottleneck" Here!

"Buffalo" Diagonally-Split Pumps like these are used in many prominent Paper mills

"Buffalo" STOCK PUMPS ARE NON CLOGGING!

● You don't need to worry about clogging—or any other kind of pump stoppage—with "Buffalo" Stock Pumps working for you!

"Buffalo" Impellers are a special wide, enclosed design. They do not depend on close running tolerances for their high efficiencies. Thus, no wear or loss of efficiency occurs. Under these practically ideal hydraulic conditions, stock flows through the impeller as it does through a pipe or nozzle. Pump casings are big, with large passages, for low velocities as further insurance against wear and wedging. Bearings, shafts and stands are equally rugged and wearworthy, and stuffing boxes extra deep.



Why not write now for Bulletin 953-F, shown above, and get the facts on the complete line of "Buffalo" Pumps for every stock? THERE'S LITERALLY NOTHING FLIMSY ABOUT THESE PUMPS! And as users of "Buffalo" Pumps will tell you, this construction saves you money year after year on the job!

YES! GO WEST!
1949 Fall Meeting TAPPI
Portland, Oregon

"Buffalo" PUMPS

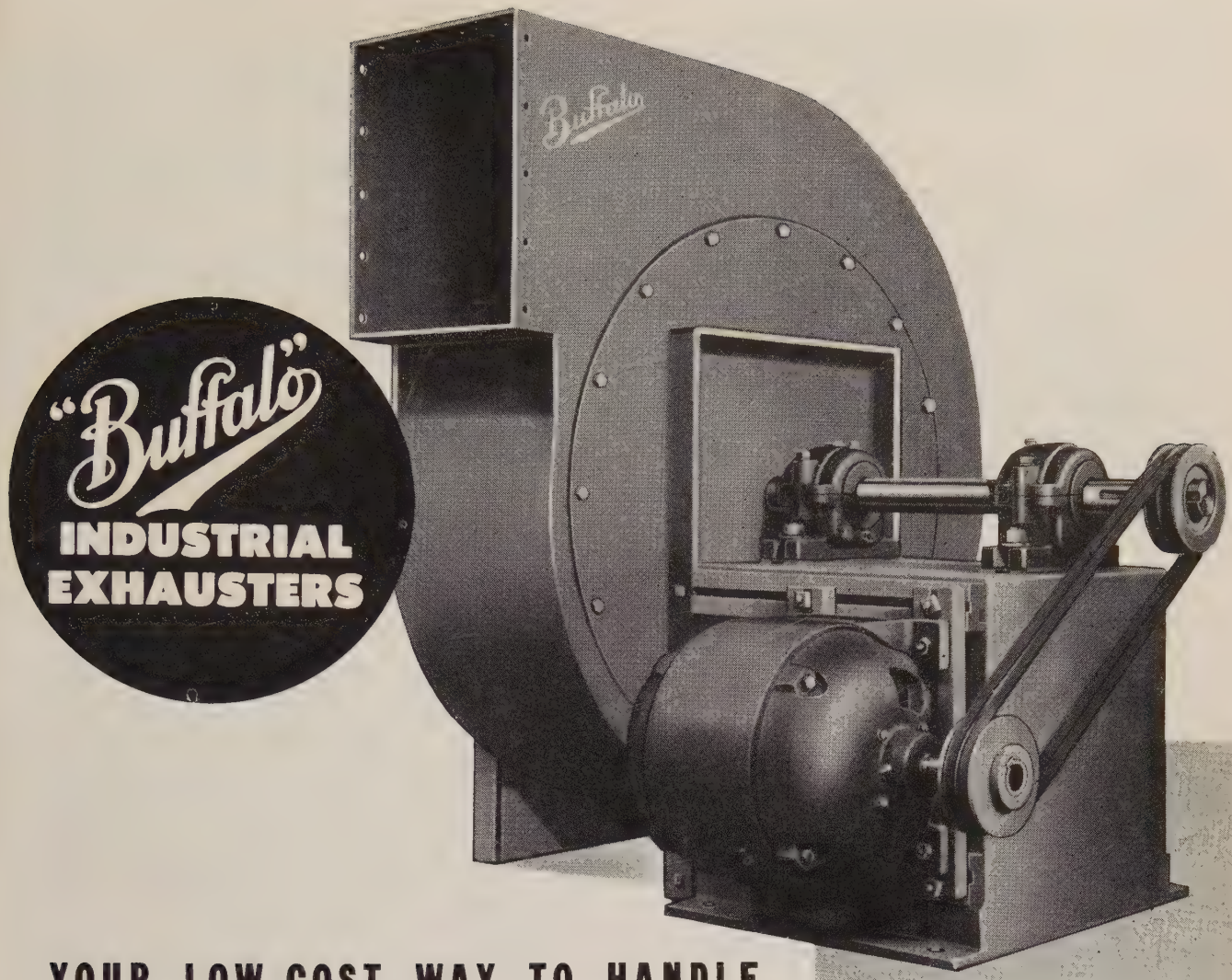
BUFFALO PUMPS INC.

528 BROADWAY BUFFALO, NEW YORK

Canada Pumps Ltd., Kitchener, Ont.

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

PERKINS
HOLYOKE
TRADE MARK REG.
SYMBOL of
HIGHEST QUALITY
B. F. PERKINS & SON, Inc.
ENGINEERS AND MANUFACTURERS
HOLYOKE, MASS.
LARGEST MANUFACTURERS OF CALENDER ROLLS IN THE WORLD



YOUR LOW-COST WAY TO HANDLE MANY A CLEANUP JOB--

Is your air loaded with substances that could be dangerous or unhealthy? Then draw off that air with "Buffalo" Industrial Exhausters! You can run these husky, high-efficiency fans day and night without worrying about breakdowns. Their all-welded construction means extra strength —but just as important, it means absence of rivets on inside surfaces—hence, less resistance to passage of air or materials. If you have a plant "cleanup" job which can be handled by a fan, why not call your "Buffalo" engineering representative and see how economically "Buffalo" Industrial Exhausters can do it?

Left, FAN ENGINEERING, 5th Edition, is a "must" for engineers! 808 pages of helpful air facts! $6.00 Postpaid in U.S.A.

- Exhausting dirt, dust grindings, grit CONTINUOUSLY
- Reducing excessive moisture — removing fogs, mists, vapors
- Conveying sawdust, chips, etc. — exhausting any materials a pneumatic system can carry
- Many other useful exhausting applications — write for Bulletin 3576 for the facts!

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528 BROADWAY BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Branch offices in all Principal Cities

VENTILATING FORCED DRAFT · AIR WASHING COOLING · AIR TEMPERING HEATING · INDUCED DRAFT EXHAUSTING PRESSURE BLOWING

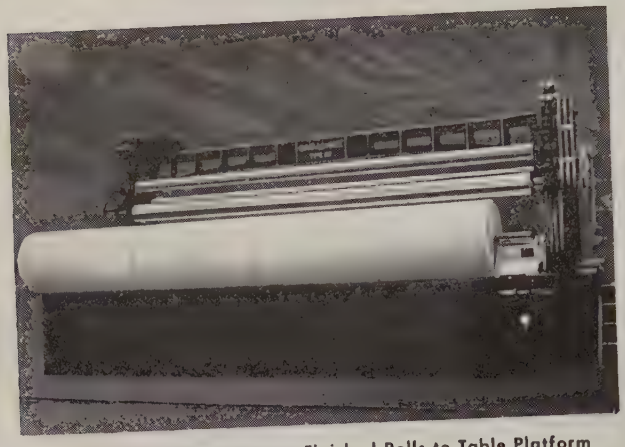
IT PAYS to unload heavy rolls this new easy way...

Camachine

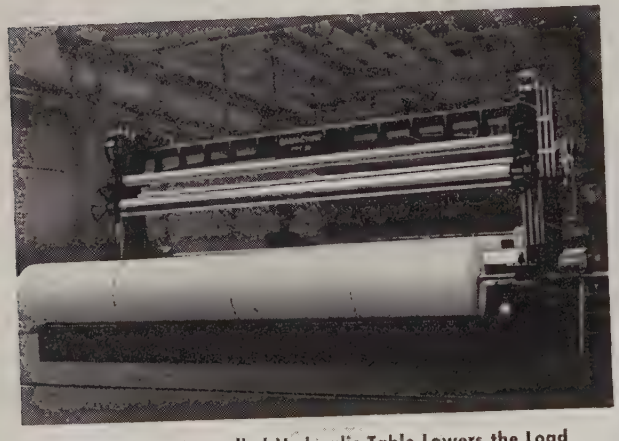
Motor Driven Roll Ejector

Hydraulic Unloading Table

Here's a cost-cutting combination that's worth investigating! On big new Camachine Mill Type Winders 20, 19 and 18, the roll ejector is standard equipment, the unloading table optional. Both are optional equipment on the smaller Camachine 14 Mill Type Winder.



Motor Driven Ejector Moves Finished Rolls to Table Platform



Push-Button Controlled Hydraulic Table Lowers the Load

8 SECONDS TO THE FLOOR
SAVE TIME • PAPER • WORK

MECHANIZED ROLL UNLOADING . . .

CAMACHINE mechanized unloading equipment speeds up handling of finished rolls—cuts costly downtime on the winder during roll changes—saves loss of paper during roll changes — and reduces the danger of damaged rolls and accidents at the winder by eliminating manual handling of the heavy rolls. Consult with Camachine engineers for complete information on the motor driven roll ejector and hydraulic roll unloading table. Also—investigate Camachine pneumatic cutter units and other new Camachine cost-cutting features designed to provide top quality winder service to the world's fastest paper machines.

Camachines *FOR FAST, TOP QUALITY ROLL PRODUCTION*

WRITE FOR LITERATURE

. . . the world over

CAMERON MACHINE COMPANY, 61 POPLAR STREET, BROOKLYN 2, N.Y.

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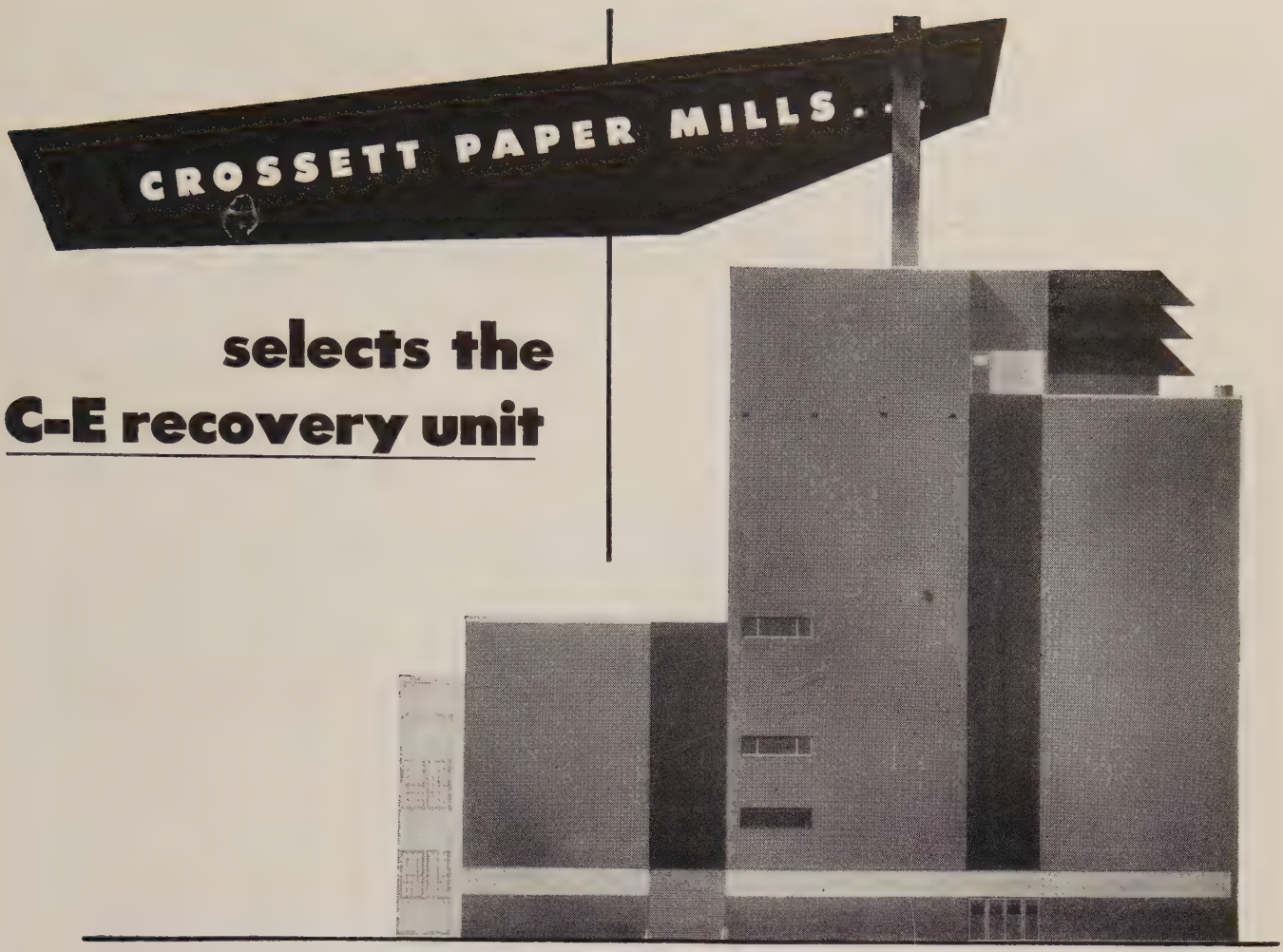


selects the C-E recovery unit

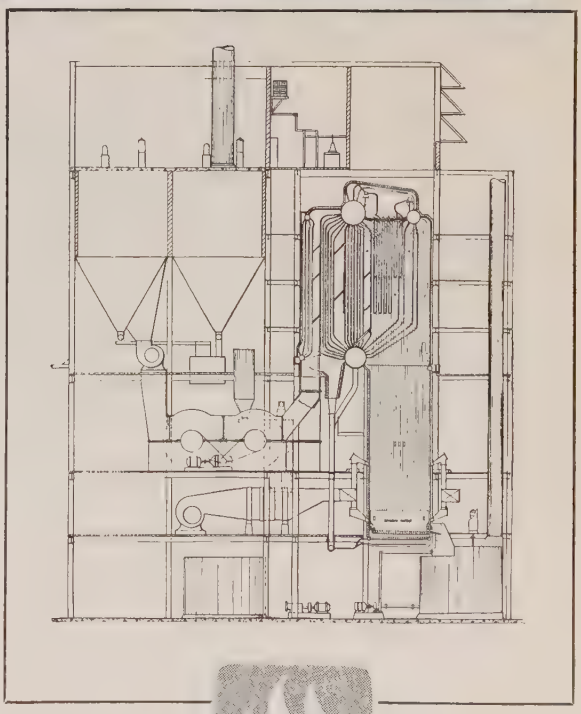
A C-E Recovery Unit, cross section of which is shown at the right, was recently purchased by Crossett Paper Mills, Crossett, Arkansas.

The new Crossett unit is designed to burn 600,000 pounds of black liquor solids per 24 hours and will produce steam at 440 psi and 700 F.

It will be housed in the very modern building illustrated above, designed by The Rust Engineering Company, engineers and constructors for the entire project.

The C-E Recovery Unit's reputation for efficiency, reliability and operating economy is built on a sound basic design enhanced over the years by the addition of carefully developed improvements. The Crossett unit will incorporate these many service-proved advantages.

B-292



COMBUSTION ENGINEERING—SUPERHEATER, INC.

A Merger of COMBUSTION ENGINEERING COMPANY, INC. and THE SUPERHEATER COMPANY

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C-E

PRODUCTS FOR THE PAPER INDUSTRY INCLUDE RECOVERY UNITS, STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; ALSO PRESSURE VESSELS

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Uniform Bulk Starch!

Uniform in texture...color...cleanliness. The same basic corn starch that is used in National's finest starch specialties is now available to you in carload quantities.

Bulk Corn Starch processed with precision controlled uniformity!

National separates all of its starch from gluten with high-speed, stainless steel, fully enclosed MERCO centrifugals. 100% mechanically! Complete separation in 3 to 5 minutes, instead of 10 to 12 hours by the open starch table method.

Drastically reduced processing time has greatly increased our production of ***Hoosier Pearl and Powdered*** bulk starches. Specialties, too, are available to meet your increased requirements for ***Paper Makers' Controlled pH Corn Starch . . . Chlorinated Corn Starch . . . Thin Boiling Corn Starch . . .*** and ***Dextrines.***

Always available: Technical service! Call on our laboratory anytime. Delivery! Prompt CL or LCL shipments from our plants or convenient warehouses.

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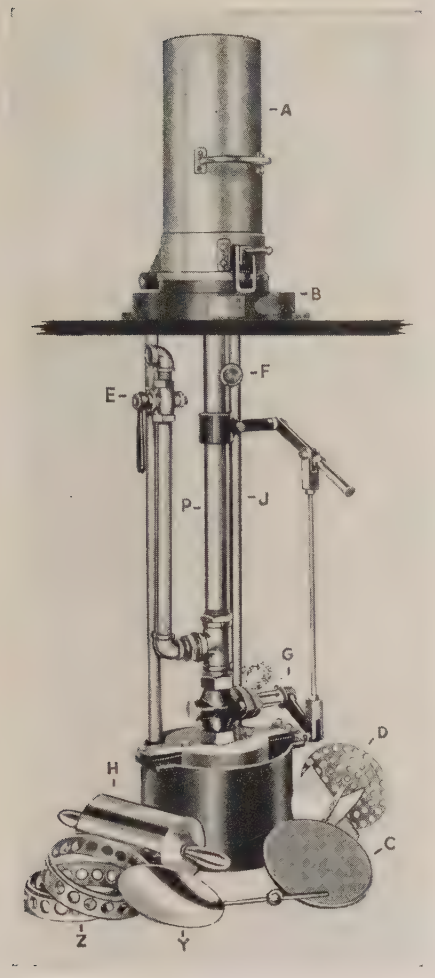
BULK STARCH
BULK STARCH
BULK STARCH

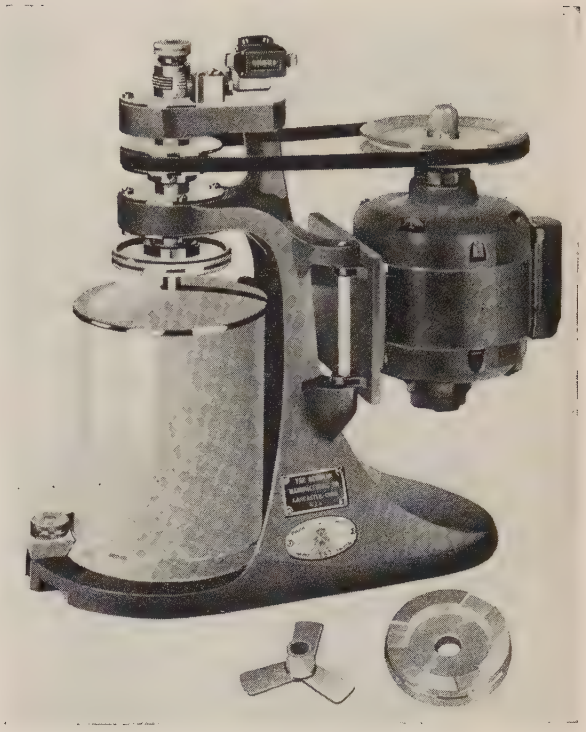
National
STARCH PRODUCTS

*TAPPI STANDARD

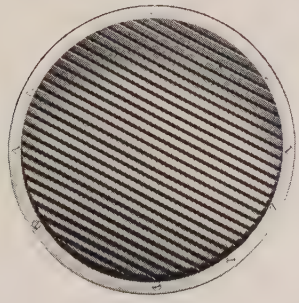
PULP TESTING — SHEET MAKING APPARATUS



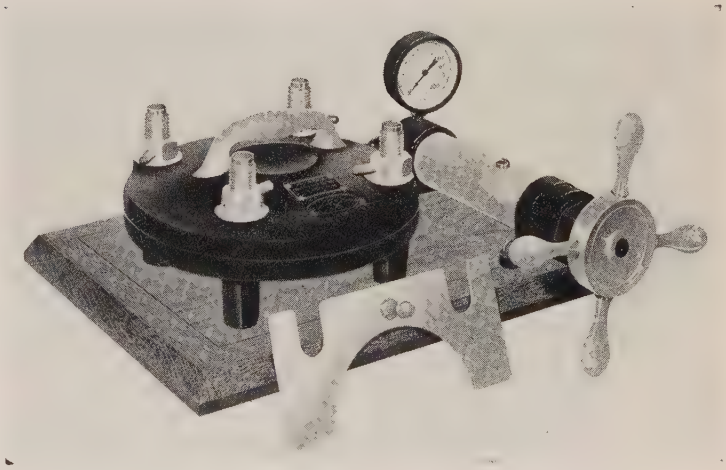
*SHEET MACHINE—DRYER RINGS—DISCS



*DISINTEGRATOR



FIBRE LENGTH CLASSIFICATION GRID
TECHNICAL ASSOCIATION PAPERS, SERIES 29-S



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NEW CATALOGUE AND PRICE GLADLY FURNISHED ON REQUEST

THE HERMANN MANUFACTURING CO.

MFGRS.: HERMANN IMPROVED CLAFLIN CONTINUOUS BEATER & REFINER

LANCASTER, OHIO

Here it is!

A new booklet, packed full of money-saving information for paper mill superintendents, engineers, maintenance men, operators

Would you like to know how leading paper mills have gained up to *ten years'* service from paper and board machines . . . and cut upkeep costs all along the way?

This new fact-packed booklet, published especially for paper and board mill men, will tell you that . . . and much, much more.

It will show you how to cut maintenance costs on filters, bleach washers, wet machines, board machines, dandy rolls—wherever rust, excessive wear, and corrosion are a threat.

Included, too, are tables showing the correct type of metal cloth to use for filters, save-alls, deckers, cylinders, and similar equipment . . . with instructions for best method of brazing, soldering, and welding.

To help you with design and fabrication problems a valuable descriptive list of important INCO Nickel Alloys is included, with sources of supply near you.

Remember . . . just one of the many helpful hints in this new booklet may save you money for years to come. Send for several copies today and route them to interested members of your plant staff.

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1949 Fall Meeting TAPPI
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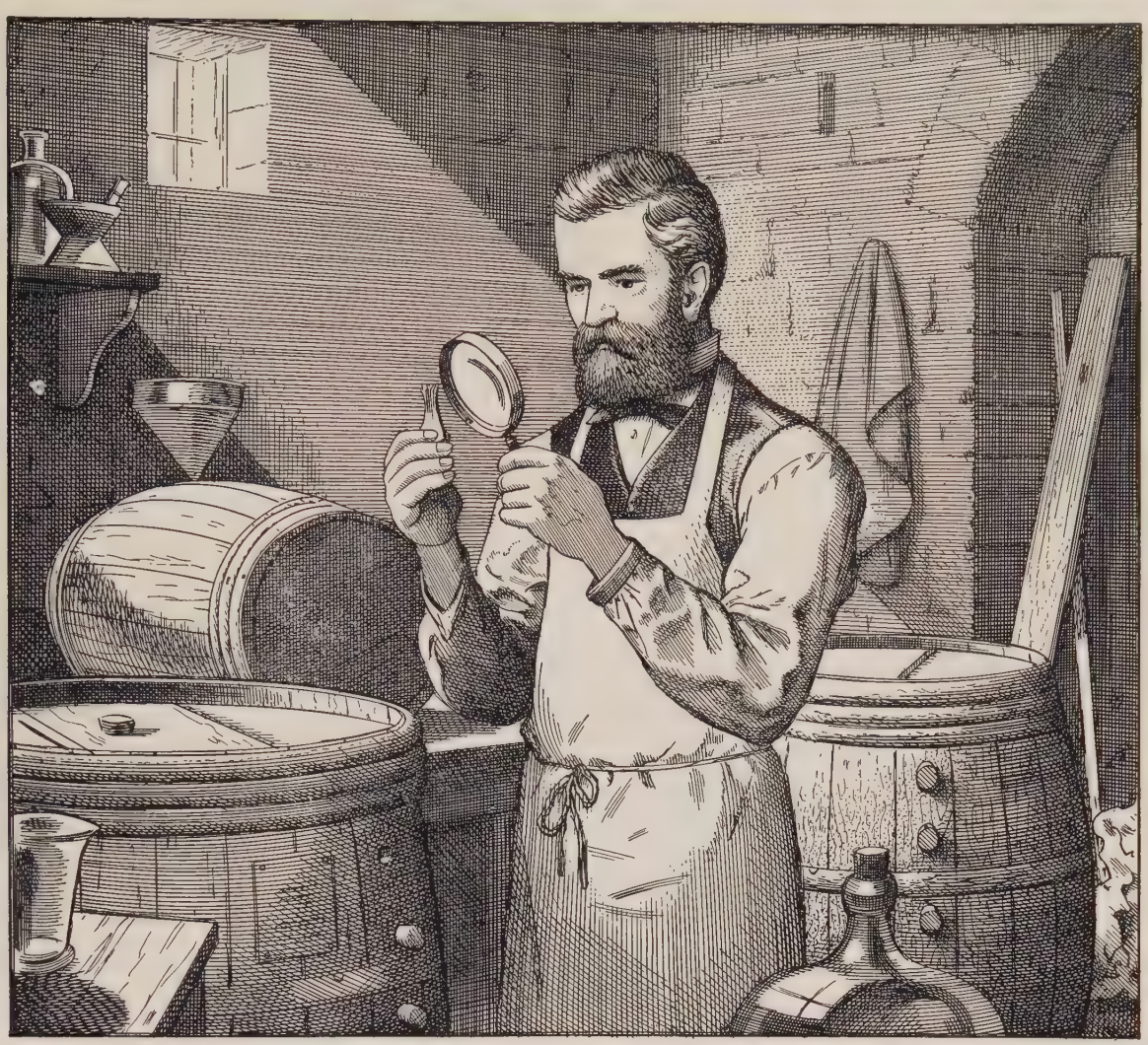


The Idea that Revolutionized Papermaking

In 1860 paper was still made almost exclusively from rags. The feverish search for a substitute went on. Then, in 1865 there flashed into the mind of Benjamin C. Tilghman, a Philadelphia chemist, an idea that was to revolutionize papermaking the world over. While experimenting in his laboratory, he noted that sulphurous acid attacked the wood in his barrels and vats, breaking down and softening the wood fiber. Others before him had observed this, but Tilghman saw what a chemical method of softening wood into pulp might mean to the paper industry.

In a small mill at Manayunk, Pennsylvania, he put his theory to practice, proved its success and was granted the first United States patent for manufacturing wood pulp by the sulphite process. Thus Tilghman became a pioneer in producing paper from wood, helped spur the growth of America's pulp and paper industry.

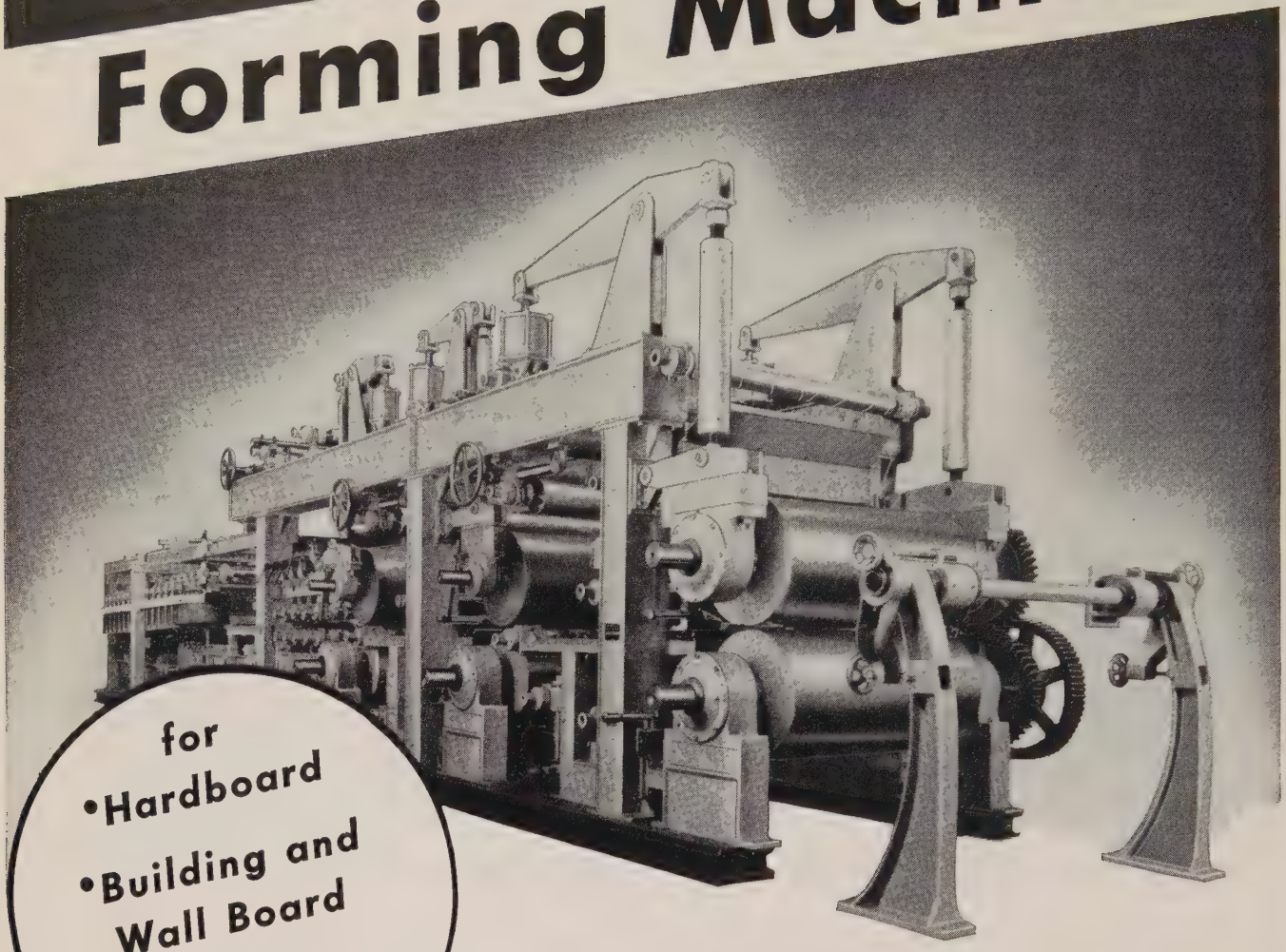
The dramatic story of paper is told in the sound-and-color film, "Paper — Pacemaker of Progress," and in a book under the same title. Both are presented by F. C. Huyck & Sons as a tribute to the Paper Industry. The book will be sent free upon request.

KENWOOD WOOL PRODUCTS

HUYCK *Felts*

F. C. HUYCK & SONS · *Kenwood Mills* · RENSSELAER, N. Y.

Sandy Hill Forming Machine



for
- Hardboard
- Building and Wall Board
- Coarse Fiber Boards

- **Silicon Bronze Headbox provides uniform thickness**
- **Adjustable Vibrator provides stock leveling action**

Proven successful in numerous installations, this improved Hardboard Machine is the product of Sandy Hill's sound engineering and production skill. Stock is introduced through a silicon bronze headbox specifically engineered to regulate the flow to provide uniform thickness across the wire. A secondary headbox, adjustable along the overhead framing, is suspended over the fourdrinier, providing a method of applying another stock to the sheet already being formed.

An adjustable vibrator is suspended between primary and secondary headbox to give additional stock leveling action. To maintain a seal and true edge on the forming sheet, a non-corrosive deckle strap arrangement is suspended at proper intervals.

Two flat suction boxes, a two-section Rotabelt and a patented Kamyr suction box assure a high degree of water removal from the sheet before the presses.

Many other typical Sandy Hill quality features are included. Let us give you further information pertaining to your individual mill requirements.

Sandy Hill Iron & Brass Works

Hudson Falls, N. Y.

Machinists and Founders Specializing in Paper and Pulp Mill Machinery

Manufacturers of
Adjustable Cylinder Vats
Cylinder Paper Machines
Pulp Grinders
Dandy Roll Drives

Pulpers or Kneaders, Voith
Thickeners
Quick Opening Gate Valves
Bertrams Flow Distributors
Bertrams Shakes

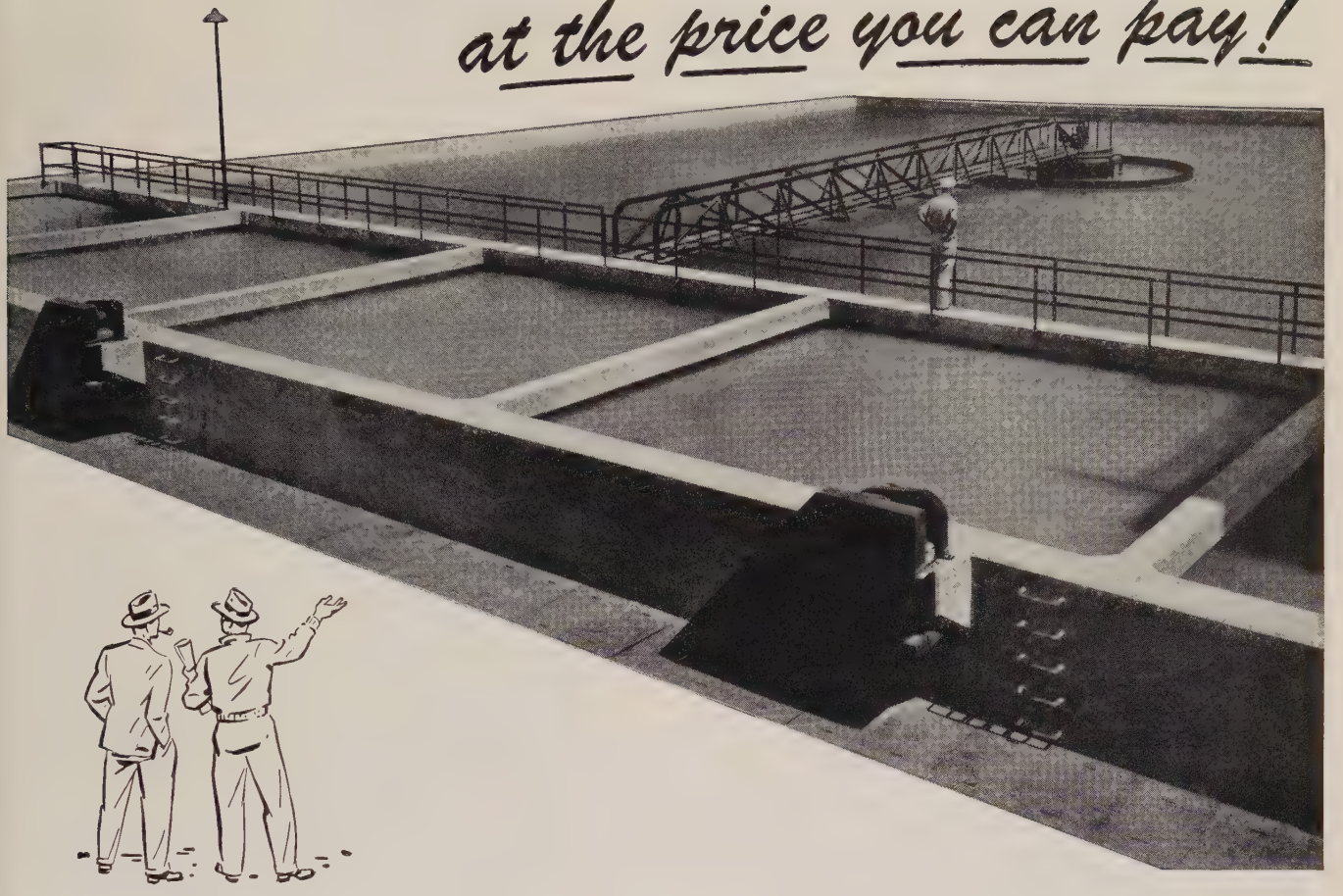
Neilson Slice
Feltless Wet Machines
"Selective" and Corner Drives
Fourdrinier Paper Machines
"Packer" Screens

Castings
Bleaching Equipment
Scofield Felt Conditioner
Cleveland Type Bearings
Shaker Screens

INDUSTRIAL WATER

of the purity you require...

at the price you can pay!



Pictured above is a typical Dorr industrial water treatment plant... modern, compact, and efficient. Installed to supply process water at a new 480 ton-per-day pulp mill, it comprises the proven combination of a Dorrco Flocculator with a Dorrco Squarex Clarifier for turbidity removal prior to filtration.

Raw water is dosed with alum, coagulation takes place in a Dorrco Flocculator shown in the foreground, after which the suspended particles are settled and removed by the Dorrco Squarex Clarifier in the background. Both units are built into a single, rectangular structure... an economical tank shape for multiple unit installations.

In order to meet every industrial water need economically, The Dorr Company offers a complete line of treatment units. Local conditions, such as raw water supply, volume of flow, and degree of purity required, will determine which is best suited to do your job at top efficiency ... and at minimum cost.

Write for Bulletin #9141, just off the press, for further information... or better still, let an experienced Dorr engineer describe this complete line of equipment in relation to your own problem.

YES! GO WEST! 1949 FALL MEETING TAPPI, PORTLAND, OREGON

DORR

RESEARCH ENGINEERING EQUIPMENT

DORRCO

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from birch and aspen *now* come semi-chemical pulps

1

YES! GO WEST!
1949 Fall Meeting TAPPI
Portland, Ore.

Partially cooked birch chips from digester—(actual size).

ABUNDANT and fast growing, these hardwoods are capable of vast increases over standard yields after sodium sulphite treatment followed by SPROUT-WALDRON refining.

Readily bleached and with high initial strengths, such pulps may be substituted for bisulphite in book and comparable grades.

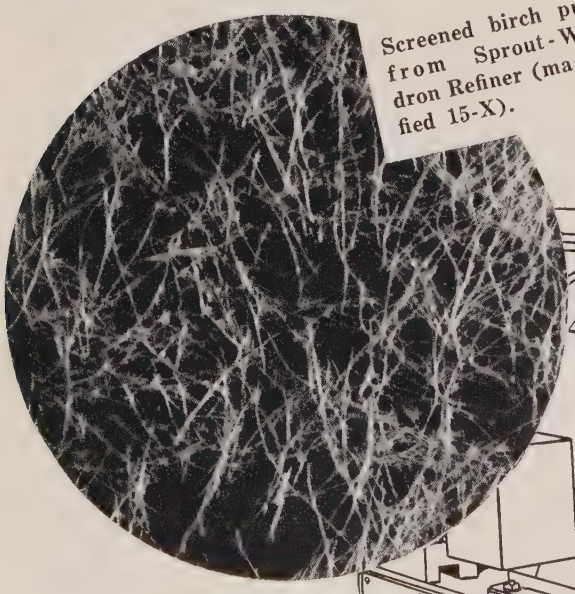
Low power and high increments of clean, uncut fibers, offer inducement to serious consideration.

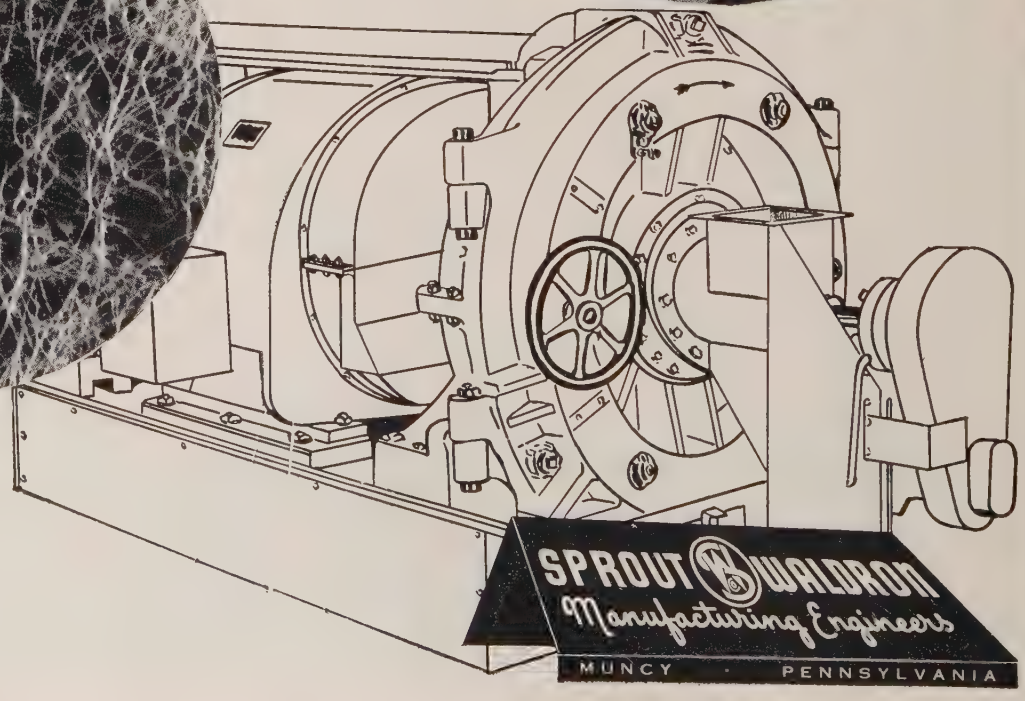
SPROUT-WALDRON offers you its technical knowledge and experience in consultation.

Sprout, Waldron & Co., 38 Waldron St., Muncy, Pa.

2

Screened birch pulp from Sprout-Waldron Refiner (magnified 15-X).





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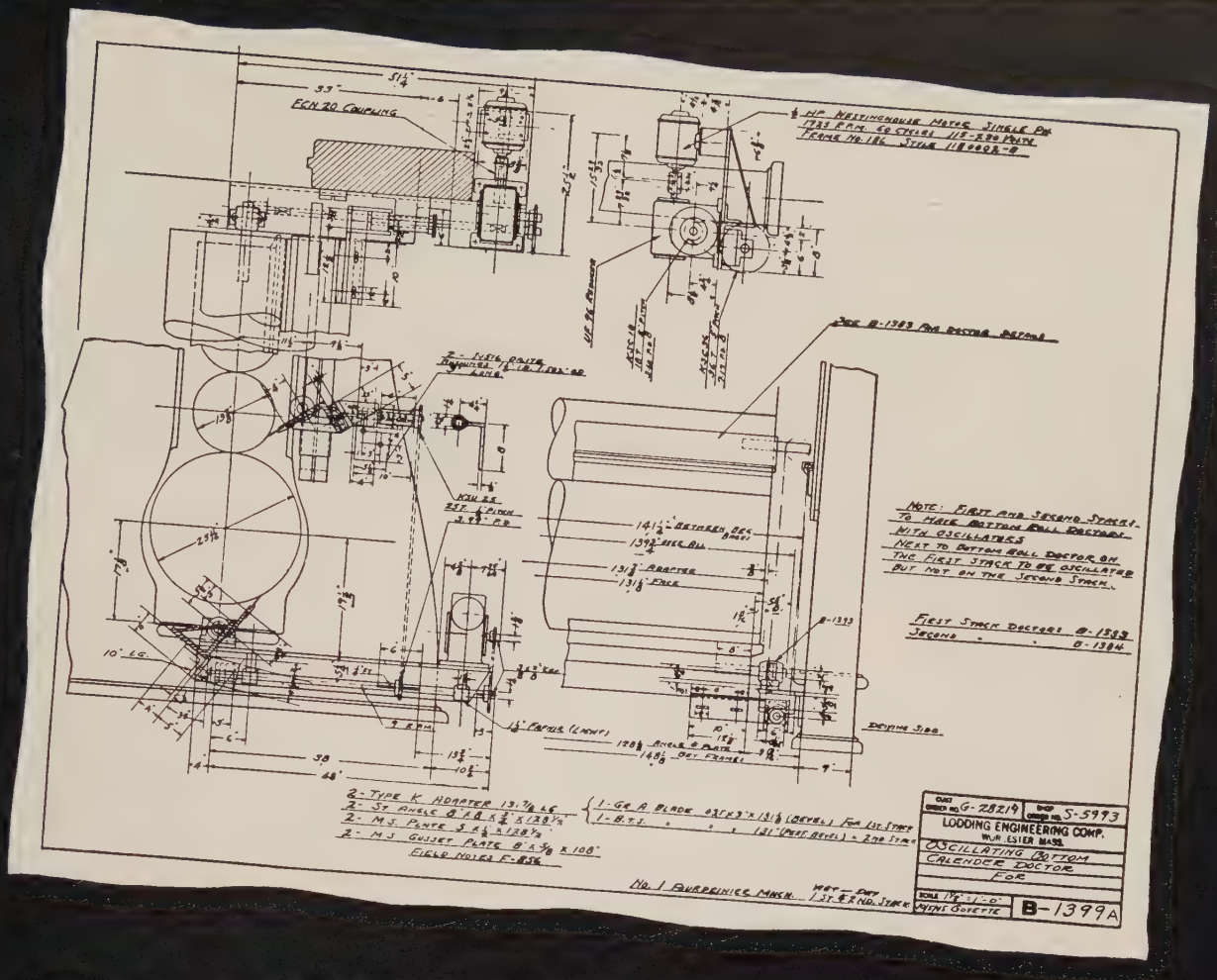
LODDING ENGINEERING COMP.
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SEPT. 11 to 15 1949 Tappi Fall Meeting

PORTLAND, OREGON

TENTATIVE PROGRAM • TECHNICAL SESSIONS • MULTNOMAH HOTEL • September 14 and 15

WEDNESDAY, September 14

1. Welcoming Remarks
2. The President's Message—*A. E. Bachmann*
3. The Secretary's Message—*R. G. Macdonald*
4. The Shibley Award
   The Meaning of the Shibley Award—*Wm. R. Barber*
   Presentation of Awards —*A. E. Bachmann*
   The Shibley Award Paper, "The Separation of Dirt from Unbleached Pulp by Centrifugal Type Classifiers"—*Vance Reynolds*, Puget Sound Pulp and Timber Company, Bellingham, Wash.
5. The Status of the Pacific Coast Pulp and Paper Industry—*Lawson Turcotte*, Vice President, Puget Sound Pulp and Timber Company, Bellingham, Wash.

Luncheon Speaker—*Harold S. Foley*, President, Powell River Paper Company, Chairman Canadian Paper and Pulp Association.

Engineering

1. Corrosion—Metallurgical Department, A. O. Smith Company, Milwaukee, Wis. Speaker to be announced.
2. Hydraulic Barking, A Summary—*Lee Hill*, Resident Engineer, Pulp Division, Weyerhaeuser Timber Company, Everett, Wash.
3. Paper Mill Design and Construction—*J. H. McCarthy*, Resident Engineer, St. Regis Paper Company, Tacoma, Wash.

Fundamental Research

1. Surface Area of Fibers as Measured by Air Permeability of Paper. *J. H. Brown*, The Institute of Paper Chemistry, Appleton, Wis.
2. An Interim Report on Lignin Studies at the University of Washington—*J. L. McCarthy*, University of Washington, Seattle, Wash.
3. A Commercial Method of Isolating Conidendrin from Waste Sulphite Liquor—*Homer Lackey, W. W. Moyer, W. M. Hearon*, Central Research and Technical Department, Crown Zellerbach Corporation, Camas, Washington.

Other papers to be announced.

Sulphite Pulping

1. Digester Linings for Bases Other Than Calcium—*A. S. Quinn*, Vice President, Stebbins Engineering Company, Seattle, Wash. (Speaker to be announced.)
2. Magnesia Base Sulphite Pulping, A Progress Report—(speaker to be announced.)
3. Ammonia Base Sulphite Pulping. Speaker to be announced.

THURSDAY, September 15

Pulpwoods, A Symposium

A discussion of comparative studies of the chemical properties of the wood, pulping behavior, and physical and chemical properties of pulps from eastern spruce, loblolly pine, western hemlock, and Douglas fir. To be presented by the Staff of The Institute of Paper Chemistry and others. Titles and authors to be announced.

Kraft Pulping

1. The Pulping Properties of Decayed Douglas Fir.—*J. H. McGovern*, Forest Products Laboratory, Madison, Wis.

Other papers to be announced.

Papermaking

1. Consumers Ideas on Paper Quality—*Frank Abbot*, President, Sunset-McKee Company, San Francisco, Calif.
2. Semichemical Pulps in Papermaking. Speaker to be announced.

Other papers to be announced.

Luncheon Speaker—*Alexander R. Heron*, Vice President, Crown Zellerbach Corporation, San Francisco, Calif.

General Session

1. The Economic and Social Status of the Pulp and Paper Industry. Speaker to be announced.
2. The Position of Cellulose as a Chemical Raw Material—*L. S. Sinness*, Director of Research, Rayon Division, E. I. du Pont de Nemours & Company, Wilmington, Del.
3. The Trends of Research in the Cellulose and Pulp Field—*Emil Heuser*, La Jolla, Calif.
4. The Problem of Education in the Pulp and Paper Field—*John G. Strange*, Secretary, The Institute of Paper Chemistry, Appleton, Wis.

Added features:

MONDAY, September 12—The Woods Trip to the Weyerhaeuser Timber Limits

TUESDAY, September 13—Mill Visits—Pulp Div., Weyerhaeuser Timber Co., Longview Fibre Co., Crown-Zellerbach Corp.

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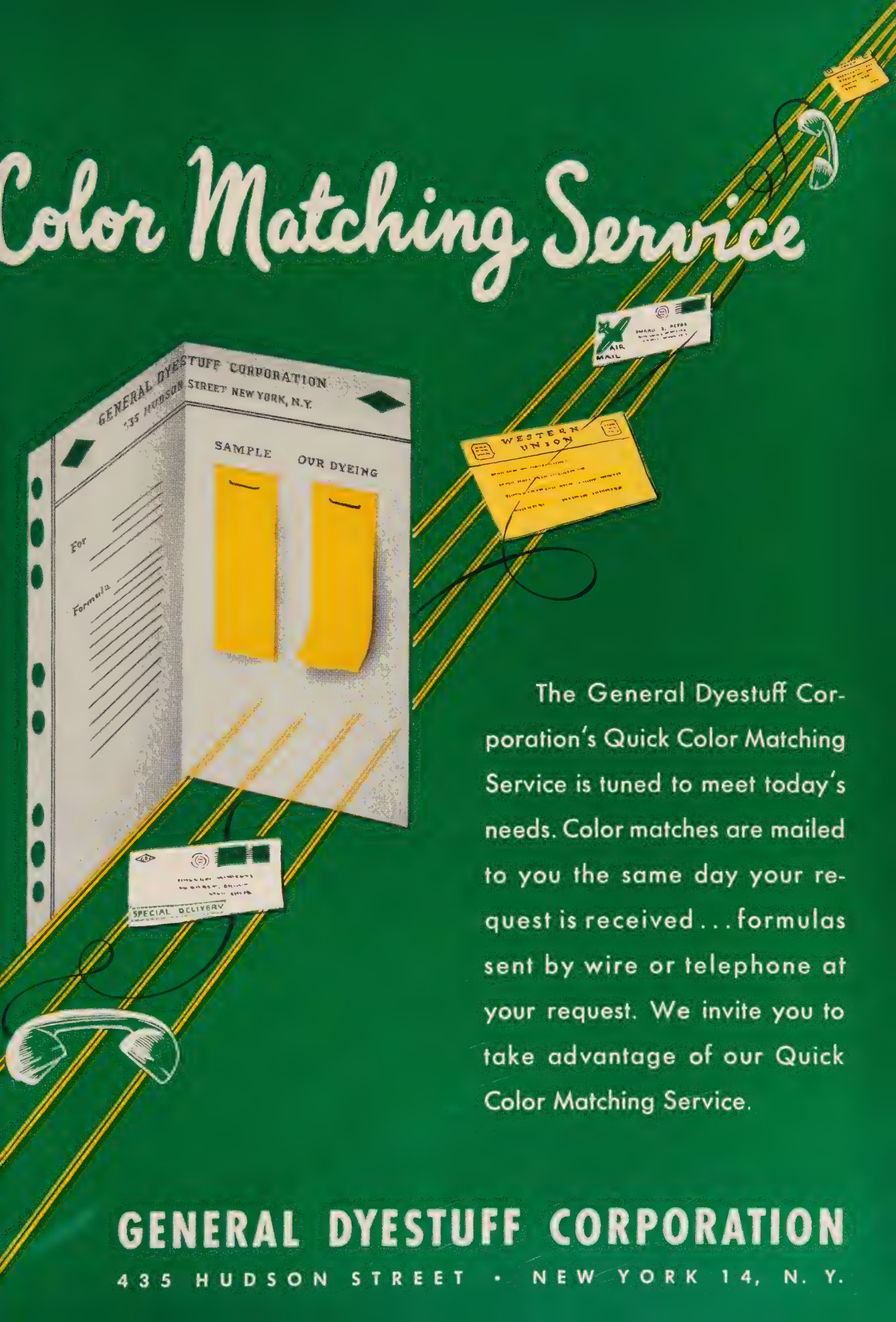

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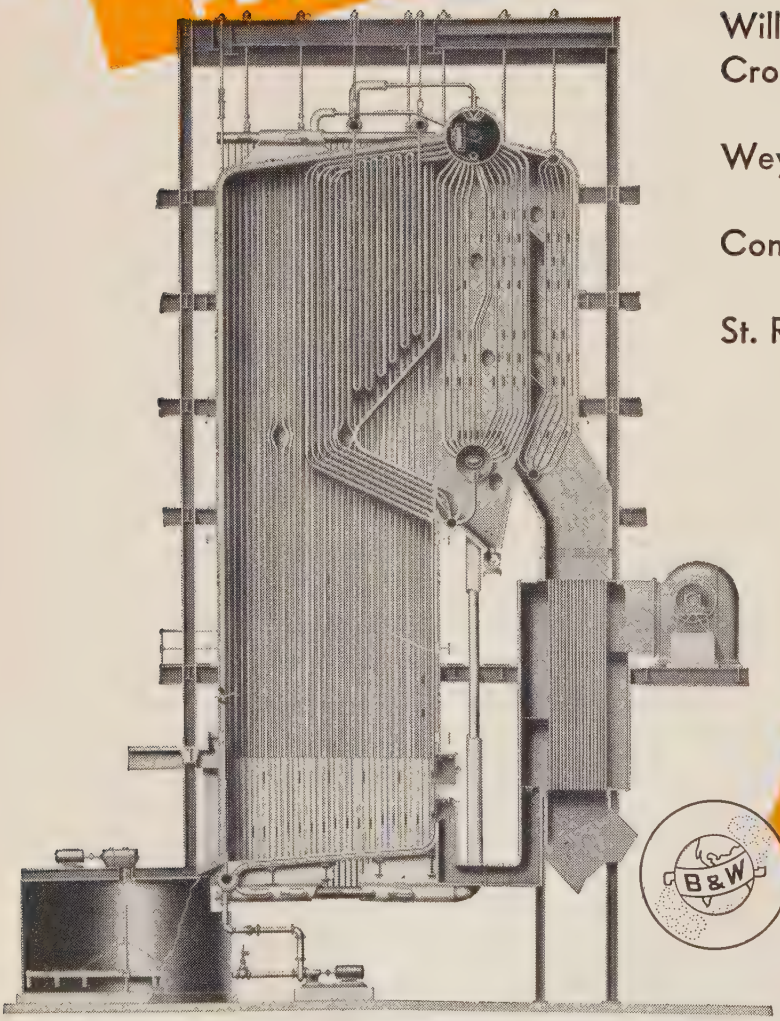

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P-41

Hydroxy Ethyl Cellulose in Paper Coating

A New Coating Process

D. ROBERT ERICKSON

A new coating process which involves the use of a hydroxy alkyl ether of cellulose as a binder is described. These ethers are selectively soluble in a critical concentration of sodium hydroxide and can be set by ion exchange wherein the sodium ion is replaced. The action is immediate to give a nontacky coating. It is claimed that a coating prepared with this material can be applied to a sheet by the conventional coating processes used on the paper machine.

In considering a new method of coating paper, the presently used methods must first be considered and evaluated. Then it is necessary to find out from the printers what they desire and need in a coated paper so that they can produce for the ultimate consumer a superior product at a legitimate price. A great deal of the cost involved in printing is due to loss of time and materials, and spoilage because the sheet may not have sufficient physical strength, gloss, will not print well, the ink will not dry evenly on it, or have good coating adhesion.

It is easy to blame all these faults on the printer, the ink maker, the plate maker, and the press manufacturer and in many cases they may be somewhat at fault. But, it is also true that the paper, which is the most expensive item involved, can and often is the real culprit in causing poor results and high costs of the finished printed product.

What then are the characteristics of the coated sheet desired by the printer so that he can lower his costs and give his customers a superior product? In the case of the letterpress printer he wants and should have:

1. Smoothness in surface topography.
2. A compressible sheet that will require less make-ready.
3. A flexible sheet—not embrittled to invite tear.
4. A more opaque sheet for less "show-through."
5. A much brighter and cleaner sheet.
6. A sheet resistant to ink pick.
7. A water-insoluble coating so sheets will not laminate if wet.
8. A nondusting sheet (comparatively).
9. A sheet that will accept and absorb the solvents in printing inks so they will set up much faster to eliminate offset.
10. A sheet on which the coating is continuous so that the ink is not printing on a discontinuous surface of fibers, clay, and adhesive.
11. A sheet that has a uniform absorption rate for inks applied to it.
12. A sheet that will allow the binder in the ink to adhere to it and not smudge off.
13. A sheet that will exhibit interfacial tension characteristics that give good clean printing from normal inks.

As all know, to date, the making and coating of paper is a compromise whereby one or more properties is lost to gain another. This is certainly true of supercalendering where a sheet is ruined in numerous ways to gain surface smoothness and, incidentally, gloss. Excessive calendering, and it usually is excessive, crushes the sheet causing a deterioration in tearing strength, compresses the sheet so it is no longer resilient, embrittles the sheet, and transparentizes the clay or other pigment coating thus lowering opacity and brightness and allowing the dirt in the rawstock to show through. This is not the worst fault. By crushing the surface clay into a glazed plate of china, all interstices and capillaries between the clay particles are eliminated so that absorbency of any ink is impaired. The ink sets very slowly, and having very little surface area to which it can attach itself, does not adhere well and can be rubbed off with the comparative ease. These are some of the many drawbacks of supercalendering, which costs from $5.00 to $10.00 per ton, to compromise for one advantage—smoothness—and yet, how else can smoothness be obtained?

When a normal type coating mix of water-soluble binder, pigment, and water is coated on a sheet of rawstock, whether the coating process be brush, air doctor, metal doctor, reverse roll, or gravure or printing press type, the coating immediately upon application sinks down into the sheet following the surface contour of the wetted rawstock and allows the fibers to stick up through the coating. The water is absorbed into the paper and carries binder with it decreasing the amount of adhesive left on the surface to bind the clay particles. The sheet is then put into a drying oven or onto a drum drier, which before evaporating the water, heats the water-adhesive mixture, lowers its viscosity, and allows more of it to drain into the sheet. The result is a coated sheet, the surface of which is rougher than the original rawstock. Certainly, the higher the solids used and the higher the viscosity coating that can be used, helps to prevent this process of impregnating the sheet with adhesive, but it is far from a continuous film overlying the fibers of the raw sheet.

If the rawstock has not been sized, the penetration of the coating is much faster, the swelling of the surface fibers is greater, and the fibers lift up through the coating which can give a very rough surface. If the raw sheet has been highly sized there is less penetration of the coating, less raising of the surface fibers, but perhaps the disadvantage of poor coating applica-

D. Robert Erickson, Member TAPPI; Consulting Chemist, Kalamazoo, Mich.

tion and poor adhesion of the coating to the stock results. In either case, a coated sheet is produced that may be suitable for offset lithography or aniline printing, but it is not suitable for letterpress. The surface contour must be level enough to allow the solids and the half-tone dots on a nonresilient plate to print an ink at normal impression pressures over a high proportion of the entire surface of the sheet rather than over a small proportion of the surface. The answer is obvious. The paper must be calendered in order to get surface levelness or smoothness. Or—must it?

Suppose a smooth film of coating could be applied to a web of rawstock and before it had a chance to sink into the sheet, it could be changed in physical form from a liquid mass to a solid which could no longer flow and would not follow the surface contour of the rawstock. We would then have a coated sheet that would be as smooth in surface topography as the coating at the time of application. This would be much the same as if a smooth, white plastic film were laminated to the relatively rough surface of the rawstock.

This process is feasible, has been successfully tried on many types of paper and board rawstocks with coat weights from 4 to 25 pounds per ream 25 × 38 —500, and is ready for commercial production.

The principle of the process lies in the fact that certain hydroxy alkyl ethers of cellulose are selectively soluble only in a critical concentration of aqueous sodium hydroxide and in no other solvents. These ethers are very suitable as adhesive binders for clay and other pigments. They are linear polymers of high molecular weight, are capable of forming self-supporting inherently flexible films, and have extremely high-adhesive properties. They can, therefore, be used in very small amounts. Because they are soluble in only one solvent, it can easily be seen that any unbalancing of this solvent equilibrium will precipitate the ether or binder from its solution. Therefore, it is possible, by either increasing the sodium hydroxide concentration, or by decreasing it, or by exchanging the sodium ion of the sodium hydroxide for any other ion, to immediately change a fluid solution to a nontacky solid. When a coating mix is made using such an adhesive for the binder, the formula will consist of clay or other pigment, dilute aqueous sodium hydroxide as the solvent, and a small proportion of the hydroxy alkyl cellulose ether as the adhesive. Immediately after coating the rawstock with such a coating, by any suitable coating machine, the wet surface is contacted with a dampening roll or other suitable method of wetting with a solution of a neutral or other salt that will simultaneously precipitate the adhesive from solution by ion exchange, occluding the clay or other pigment in the smooth precipitated film and also will neutralize the sodium hydroxide of the solvent and bring the pH of the coating to any desired end point. The excess of the precipitating and neutralizing salt solution together with the nonre-entrant water of the original coating are removed by passing the sheet through squeeze or press rolls, such as are used on a size press. The caustic of the solvent does not harm the rawstock in any way as it is neutralized almost at the same time that it is applied. By ion interchange of the sodium ion of the sodium hydroxide for some other ion of the salt used to precipitate and neutralize, no acid is necessary for neutralization to cause excess acidity that would be deleterious to the rawstock.

The chemistry of this ion exchange is very simple. When a salt such as ammonium sulphate is used as a precipitator and neutralizer, the sodium ions of the aqueous sodium hydroxide solvent for the cellulose ether binder exchange for the ammonium ions of the ammonium sulphate immediately forming sodium sulphate and ammonium hydroxide. The binder is not soluble in ammonium hydroxide so is immediately precipitated to a nontacky solid form. The ammonia of the ammonium hydroxide formed is volatilized leaving a substantially neutral film.

If an acid salt is used as the precipitator, the reaction products are, of course, the added sodium to the salt used, and water. Combinations of acid salts can be used to give any pH desired in the finished film coating.

Other nonreacting substances may also be present in the precipitating bath that may impart various characteristics to the surface of the coated film without involving the cost of having to be dispersed throughout the entire coating. A choice of ionic charges can easily be imparted to the surface in this manner. Colloidal gels or sols can be applied to the coated surface in extremely thin films. Any of the commonly used pigments may be used in this process.

A typical coating color is prepared as follows:

93	parts clay chemically dispersed in
40	parts water by addition of NaOH to a pH of approximately 10.25 to give a clay slip of 70% solids.
2.5	parts NaOH in
14.5	parts H_2O to give a final 5% NaOH content on total water.
7	parts alkali soluble hydroxy ethyl cellulose in
88	parts H_2O containing
5	parts NaOH
250	parts of a 40% solids coating in a 5% aqueous NaOH solution containing 7% of binder based on the solids.

This coating color is stable indefinitely and is completely resistant to bacterial growth. It is applied to the coating rawstock by any of the known methods, but preferably by a method that does not apply a pattern. Immediately after the coating is applied, it is contacted with an aqueous solution of salt capable of ion exchange with the sodium hydroxide present in the coating. Immediately following this contact, all excess setting solution and some of the water in the original coating is squeezed out by passing the sheet between two rollers, one of which has a somewhat resilient surface. A normal size press is very suitable for this operation. The sheet is then dried, preferably in contact with a drum drier or a series of paper machine drier rolls. This drying under tension is important to eliminate cockle from shrinkage. The finished dried sheet is level in surface contour to the extent that it does not have to be calendered.

The advantages of this sheet must be apparent.

1. More compressibility.
2. More flexibility.
3. Much greater brightness.
4. Much better opacity.

5. Much greater affinity for ink. (Ink will set up to 50 times as fast as on normally coated and calendered sheet.)
6. Much better lay of ink on this surface (less mottle).
7. Much better adhesion of ink to this surface.
8. Water insolubility of the coating.
9. A sheet that can be standardized and duplicated.
10. A better printing sheet.

The speed at which this method of coating can be used is entirely dependent on the mechanical capabilities of the coater and drying units. The time necessary for the ion exchange to take place is so short that it need not be taken into consideration on speed of coating.

The process is ideally suited for "on the machine" coating especially on machines that already include a size press. The press can be used for setting or precipitating the coating and squeezing out the excess water. An applicator roll and air doctor can be placed just ahead of the press rolls.

The process is also ideally suited for simultaneous double side coating as no sticking is possible on the drying drums.

The process described is certainly a departure from the normal approach to the problem and should provoke a discussion that will interest and possibly greatly benefit the paper coating industry.

RECEIVED April 14, 1949. Presented at the Coating Conference of the Technical Association of the Pulp & Paper Industry held at the Hotel Pantlind, Grand Rapids, Mich., April 26 and 27, 1949.

Commercial Variance in Schopper Folding Tests

H. S. SPENCER

Samples of paper were sent to eight different laboratories which tested them for folding strength using the Schopper tester. The summary shows that widely varying results were obtained by the different laboratories. Tests from each laboratory also show variations over a wide range. Accordingly, it would seem that specifications based on an accuracy of 10 to 20% are too rigid. Indications are that comparisons made on one tester are more valuable than comparisons between instruments.

EIGHT DIFFERENT laboratories in the following organizations agreed to make folding tests on paper provided by the Howard Smith Paper Mills for the information they would obtain in instrument comparison. These were as follows: U. S. Bureau of Standards, Strathmore Paper Co., Eastman Kodak Co., Institute of Paper Chemistry, Hammermill Paper Co., Pulp and Paper Research Institute, Electrical Testing Laboratories, and Howard Smith Paper Mills Ltd.

All of the companies made the tests, after conditioning the paper at 50% relative humidity and 70°F., according to TAPPI Standard T423 m-45. This method calls for folding endurance to be reported as the average of "at least ten specimens cut from each principal direction." All of the laboratories exceeded considerably the minimum of ten tests.

The samples of paper were carefully selected by a skilled chemist having great experience in testing procedure. All sheets were examined carefully to make sure that the basis weight and formation were uniform, and all doubtful ones were discarded. The paper had been cut on a single sheet cutter and the selection of eight groups of samples was carried out under standard sampling procedure.

Previous articles (*1*) have been written regarding the Schopper folder, and the following comments are made not so much for skilled testers of paper as for the nontechnical men who may be purchasing or specifying paper and those operators who wish to use the Schopper fold tester for control or for comparison. Unless it is generally known within what limit of accuracy these machines can be expected to operate, misunderstandings are bound to arise, with the result that impossible standards may be set up or the interpretation of results will be misleading.

The summary shows that different laboratories found widely varying results, and each laboratory recorded variations over a wide range.

The great difficulty in calibrating these machines indicates how far out the averages of one test may be from the averages of another, even when all precautions for good testing methods have been taken. When few tests are made, as is bound to occur when used for control, still greater variations are certain to take place.

Spot checks made by customers who may delegate the test to people not skilled in the use of the Schopper fold test, or testing methods, can often result in figures so inaccurate, as to be not only misleading, but completely useless.

If a laboratory can keep one Schopper folding tester in good condition comparisons made on this tester may be more valuable than when compared to another tester which is probably not calibrated sufficiently accurately even under the best of conditions.

It is believed that this is a comprehensive and thoroughly comparative test, which may be used as a reference by people confronted with the problem of meeting certain specifications on folding tests.

For those who wish to study the mathematics of these results an appendix is attached containing a summary by W. Boyd Campbell of Forest Products Laboratory.

LITERATURE CITED

1. Reitz, L. K., and Sillay, F. J., *Tech. Assoc. Papers* 31:98–102 (1948).

H. S. SPENCER, Member TAPPI; Mill Manager, Howard Smith Paper Mills Ltd., Beauharnois, Que.

APPENDIX*

In considering the results of the combined lot of tests as a measure of what may normally be expected of folding tests, the data should be treated in such a way as to bring out what range of results would be expected if only ten tests had been reported. Where larger numbers of tests were made, as in the case of laboratory F which made 250 tests in each direction, the whole array of data can be used as if a considerable number of separate tests of ten specimens each were made.

As the various laboratories did not all make the same number of tests or group those made in the same way in all cases, it is necessary to analyze the results in each case to bring out the degree of variation to be expected.

	Machine direction		Cross direction		Combined machine and cross direction	
Laboratory	No. of tests	Av. tests	No. of tests	Av. tests	No. of tests	Av. tests
A	100	1774	100	1999	200	1886
B	50	1817	50	2034	100	1926
C	250	2047	225	2055	475	2051
D	50	1121	50	1145	100	1133
E	250	2000	250	2358	500	2179
F	250	1919	250	1761	500	1844
G	250	1652	250	1764	500	1710
H	40	1860	40	2103	80	1982

Note: The eight participating laboratories are not listed in the order given in the text.

Laboratory A made four tests on each of 25 sheets. From the data of these 100 tests it is readily possible to calculate the mean deviation of the individual tests from the average of the whole. The mean deviation of the average of a chance group of N tests from the average of a very large number of tests is calculated as $D\sqrt{N-1}$, where D is the mean deviation of individual tests. For a group where $N = 10$, the mean deviation of the average of the 10 is, therefore $^1/_3$ of the mean deviation of the individual tests.

Laboratory B made two tests on each of 25 sheets, a total of 50 tests. These data can be treated as in the case of laboratory A.

Laboratory C reported the averages of ten tests on each of 25 sheets. In this case the mean deviation of the groups of ten can be calculated directly.

Laboratory D reported two tests on each of 25 sheets but there is obviously something wrong with these data as they show only about one-half the endurance reported by the other laboratories. In the analysis these data are omitted.

Laboratory H reported 40 individual tests of which about $^4/_5$ were made on one sheet and $^1/_5$ on another sheet. The other 23 sheets were disregarded. This may, at first sight, seem meager but it is to be remembered that the whole sample of 25 sheets was prepared so as to be, in effect, one large sheet of as near uniform quality as possible. There is not a great deal of difference to be expected from testing 40 specimens from two sheets as compared with testing 50 specimens from 25 sheets. The results are treated as in the case of laboratory B.

Laboratory F, like C, reported averages of ten tests on each of 25 sheets but give all the individual tests as well. These data are treated as in the case of C.

Laboratory G reported averages of an unmentioned number of tests (presumably 10) on each of 25 sheets. These data are also treated as in the cases of C and F.

The results of the analysis follow:

Laboratory	A	B	C	H	F	G
Machine direction, No. of tests	100	50	250	40	250	250
Average test	1774	1817	2047	1860	1919	1652
Mean deviation of individual tests	247	183	358[a]	236	345[a]	240[a]
Mean deviation of average of 10 tests	82[a]	61[a]	119	79[a]	115	80
Permissible deviation (of group of 10)	205	152	298	196	288	200

[a] Deviation for group average calculated from individual deviations or vice versa. Results for E not received in time for this analysis.

In about 96% of cases the actual deviation will fall within 2.5 times the mean deviation. The lower line of the table shows the values of such actual deviations as might well occur if the laboratory made tests of ten specimens, as is permitted by the standard method. The possible results which might be reported in such cases would lie in the range given by (average of large number ± 2.5 times deviation of average of 10). These ranges are as follows:

Laboratory	"Permissible ranges"		
A	1774 ± 205	or	1569 to 1979
B	1817 ± 152	or	1665 to 1969
C	2047 ± 298	or	1749 to 2345
H	1860 ± 196	or	1664 to 2056
F	1919 ± 288	or	1631 to 2207
G	1652 ± 200	or	1452 to 1852

As all these "permissible ranges" overlap, they may all be considered good or valid tests. Accordingly, there may be expected, on the basis of these data, reports varying all the way from 1450 to 2340, any of which must be considered a "good" test! And this is on a high-grade paper, selected for uniformity. Lower grades would show even wider variations.

In the case of some of the laboratories a comparison can be made between the ranges to be expected from the above calculation and those actually found for averages of ten tests.

Laboratory	Range calculated	Range found
C	1749 to 2345	1577 to 2321
F	1631 to 2207	1658 to 2133
G	1452 to 1852	1510 to 1900

From the above it should be clear that the folding test should not be used as a specification for high-grade papers unless a tolerance of at least 20% is also included in the specification. The tolerance for papers of ordinary grades should be greater, probably at least 30%.

* In this discussion only the tests made in machine direction are considered. Similar conclusions can be drawn from tests in the cross direction.

RECEIVED Feb. 18, 1949. Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, Hotel Commodore, New York, N. Y., Feb. 21–24, 1949.

Elimination of Suction Roll Noise

JOHN P. NASH

The combined efforts of the Kimberly-Clark Corporation and the Beloit Iron Works have resulted in a workable silencer for suction rolls. This silencer, invented in 1937 by E. J. Abbott and J. D. Kraus, provides an air gap on the leaving edge of the suction box so that air must enter the evacuated holes of the shell slowly, the pressure wave which causes the noise in unsilenced rolls being thereby eliminated. It was long thought that this silencer was impractical for continuous mill operation, but further investigation has revealed that it can be installed successfully in the suction rolls of creped wadding machines. Installations have been made with excellent success on eight Kimberly-Clark creped wadding machines, loudness reductions of more than 80% being obtained on some rolls, and it is believed that similar results can be achieved on paper machines.

The Kimberly-Clark Corporation and the Beloit Iron Works have in recent years devoted a considerable amount of effort toward solving the problem of noise from suction rolls. As a consequence of the efforts of both companies a workable solution to the problem has been evolved for creped wadding machines, and there is every reason to believe that it will be equally effective for other kinds of machines. It is the desire of the Beloit Iron Works and the Kimberly-Clark Corporation that the invention be made widely available to the paper industry in order that the benefits of quiet machine operation may be realized to the fullest possible extent, thereby improving working conditions in modern high-speed mills. This paper has been prepared to acquaint the paper industry with the method of solving the problem.

Nearly every industry has its noise problems, but the paper industry is probably unique in that its principal noise problem, and it is a serious problem, is one of fixed frequency sounds—that is, sounds which are literally musical notes. These sounds originate in the suction rolls of the machines, and as the speeds of machines have risen over the years the sounds have increased correspondingly. This has been particularly true in creped wadding mills where a combination of high speed and close proximity of several suction rolls has resulted in very high loudness levels. As time passes, however, and as the speed of paper machines rises, the paper mill is becoming increasingly noisier.

In 1937 Ernest J. Abbott of the Physicists Research Company was engaged by the Kimberly-Clark Corporation to make an analysis of noise levels in its creped wadding mill at Niagara Falls, New York. After this work had been done, it was suggested by the Kimberly-Clark Corporation that the Beloit Iron Works, which for many years had designed and built suction rolls for the Kimberly-Clark Corporation, engage Abbott to undertake a study of the causes of suction roll noise with the object of finding a solution. The Beloit Iron Works was in complete agreement with this proposal, and, accordingly, Abbott and his associate J. D. Kraus set up in their laboratory at Ann Arbor, Michigan a test stand containing a small suction roll with which they were able to duplicate suction roll noises over a wide range of machine speeds, vacuum levels, felt wraps, and suction box positions.

In a remarkably short length of time Abbott and Kraus had a solution to the problem, and a demonstration which was witnessed by representatives of the Beloit Iron Works and of the Kimberly-Clark Corporation was held at the Ann Arbor Laboratory in September, 1937. Within a week after this demonstration the new No. 5 creped wadding machine was started at the Kimberly-Clark Lakeview Mill at Neenah, Wis., and the suction rolls of this machine were provided with the silencer which had been developed by Abbott and Kraus. There is no available information on the loudness level when the machine was started, but Abbott and Kraus stated that "the noise level was much less than on any of the other machines of this type."

The work done by Abbott and Kraus is described in a series of reports written in 1938 to the Beloit Iron Works, and the end result is described in U. S. patent 2,274,641, applied for in 1938 and granted in 1942 to Abbott and Kraus. The Beloit Iron Works holds exclusive rights to this patent in the paper field.

This invention was incorporated into the suction rolls built by the Beloit Iron Works. There are not a great deal of data upon the loudness levels of creped wadding machines after the installation of this silencer, but it is known that at one time several years ago the No. 5 Lakeview machine was so quiet that the gears were important noise sources.

At the time the Kimberly-Clark Corporation began to study the problem intensively, however, it was a commonly accepted belief that the Abbott-Kraus silencer could not be made to operate effectively in the mills. This belief was held not only by Kimberly-Clark but also by Beloit. The ineffectiveness was attributed to an inherent difficulty in adjusting the silencer properly and to a change in silencer dimensions from wear.

THE ABBOTT-KRAUS SILENCER

According to Abbott and Kraus, the noise from suction rolls is caused primarily by pressure waves which are set up by a rapid rush of air into the holes of the suction roll shell after the holes have been evacuated and as they pass over the leaving edge of the suction box. This rush of air usually comes from within the shell because the holes are closed from the outside by the felt or by the wire and sheet. The invention consists of a piece of material, usually the same as that

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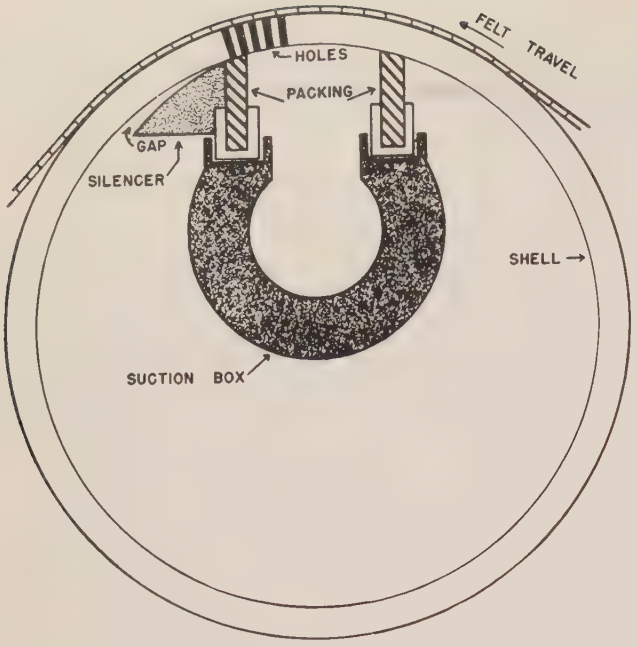

Fig. 1. The Abbott-Kraus silencer

from which the seals of the suction box are made, which is fitted to the packing of the suction box in such a way as to form an air gap. Such a silencer is illustrated in Fig. 1. With the silencer in place air cannot rush rapidly into the holes of the shell; it must go in slowly because of the restricted passage between the silencer and the shell.

Abbott and Kraus have recommended that the silencer be shaped so that the surface next to the shell will have the same radius of curvature as the shell, the center of curvature being appropriately displaced so that the silencer will have a suitable gap. It is clear that some care must be exercised in the determination of the dimensions of the silencer and in its installation in the roll. The gaps are not large; an opening of approximately $^1/_{32}$ inch at the outside edge of a 2-inch silencer might be appropriate for some conditions. The installation of the silencer must be carefully made for it is essential that the silencer not interfere with the vacuum of the suction box and yet that it have an air gap that closes uniformly from a maximum opening at the outer edge of the silencer to zero against the suction box seal.

The choice of correct dimensions for silencers depends upon several factors, and a silencer which is correctly chosen for one set of conditions may not be the proper one for a different set of conditions. It is true that a silencer may give a considerable amount of quieting over a rather wide range of operating conditions, but for maximum effectiveness a silencer should be chosen for the specific conditions under which it is to operate.

Abbott and Kraus give the following formula* for choosing a silencer:

$$G = 0.43L(kV)^{0.7}$$

in which G is the gap opening, L is the silencer length, V is the volume of a hole in the suction roll shell, and k is a correction factor for the reduction in the effective volume of the shell hole because of the presence of water in the hole. The value of k depends upon a number of factors, among them being the width of the suction box, the vacuum level, the felt density, and the speed. The determination of a suitable value for k is the most difficult part of the use of this formula. The value of k lies between *0* and *1*. According to Abbott and Kraus it probably approaches *1* for machine speeds above 2000 f.p.m., is probably less than $^1/_4$ for speeds less than 500 f.p.m., and is estimated to have a value of about 0.8 for speeds in the neighborhood of 1500 f.p.m. It is apparent that even if k is known, appreciable differences in correct silencer dimensions result if a machine is to operate over a relatively wide range of speeds.

As for the effectiveness of silencers of this kind, Abbott and Kraus were able to obtain reductions in loudness level of about 30 decibels with their test stand. This means that the reduced sound was only about $^1/_{15}$ as loud as the original sound, and a listener hearing such a reduction would be given the impression that the vacuum had been shut off. Indeed, with a properly adjusted silencer there is an almost negligible difference between the loudness levels with no vacuum and with, say, 17 inches of vacuum.

Experimental Work at Kimberly-Clark

The work of Abbott and Kraus was done in 1937. In the years that followed the creped wadding machines in the Kimberly-Clark mills grew noisier and noisier in spite of the fact that the suction rolls were provided with silencers. During these years the problem was being studied in the research laboratories, but in 1946 it was decided that work on the problem should be greatly increased. Consequently an intensive research program was undertaken.

The Beloit Iron Works lent the suction roll shell which had been used by Abbott and Kraus, and with this as a starting point a test stand was built with which suction roll noise performance could be duplicated over a wide range of experimental conditions. The test stand is shown in Fig. 2, the principal components being as follows:

Suction roll: Brass shell 10 inches inside diameter and 1 inch thick with rubber cover 1 inch thick. Conventional straight drilling.

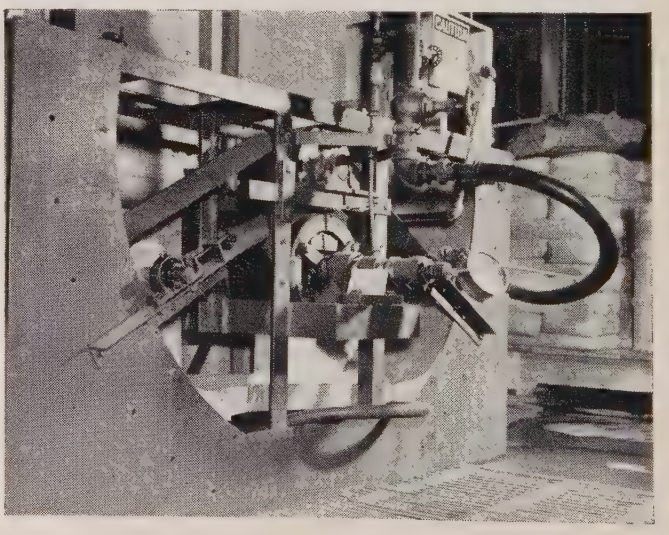

Fig. 2. Test stand for studying suction roll noise

* Silencing Gaps for Suction Rolls, report to Beloit Iron Works, April 1938.

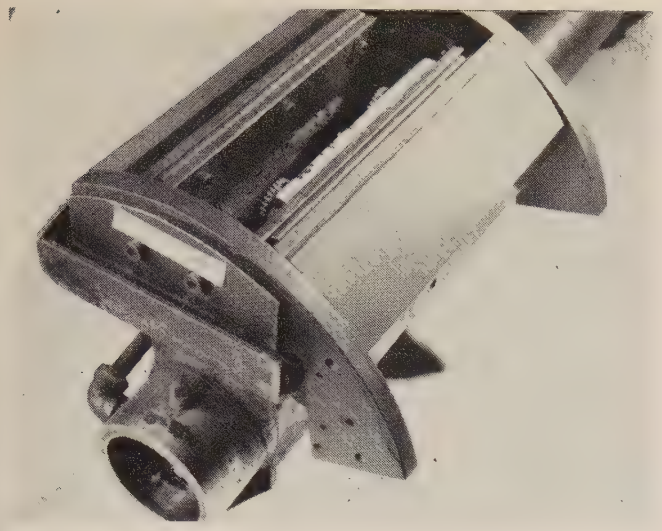

Fig. 3. Suction box with adjustable silencer

Suction box: $3^{5}/_{32}$ inches wide by 8 inches long inside the seals. Box position is continuously adjustable at any time.

Felt: Top felt from creped wadding machine. Any mill felt wrap can be duplicated, and experimental wraps can be set up.

Drive: 5-hp. motor through Link Belt P.I.V. speed changer. Speeds are continuously adjustable from 950 to 2950 f.p.m.

Vacuum: Levels attainable to 17 inches of mercury.

All sound level measurements were made with a General Radio Type 759-B sound level meter.

One of the first experiments tried was with a silencer of the Abbott-Kraus type similar to those then being used in the Kimberly-Clark creped wadding machines. The noise level was reduced, but the reduction was not great enough. It is now known that this silencer was poorly designed, but at that time the experiment merely strengthened a desire to find some other solution.

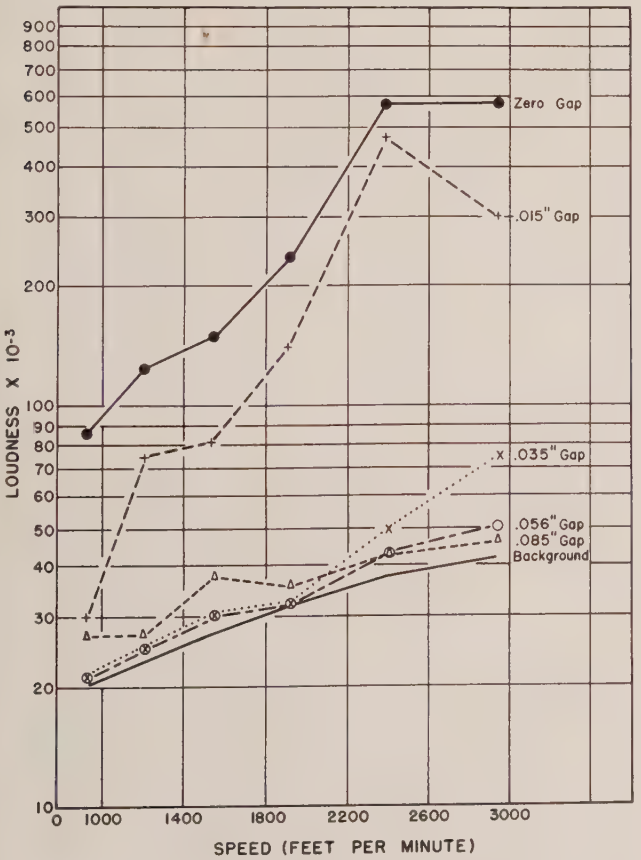

Fig. 4. Effect of gap opening on loudness (main press wrap)

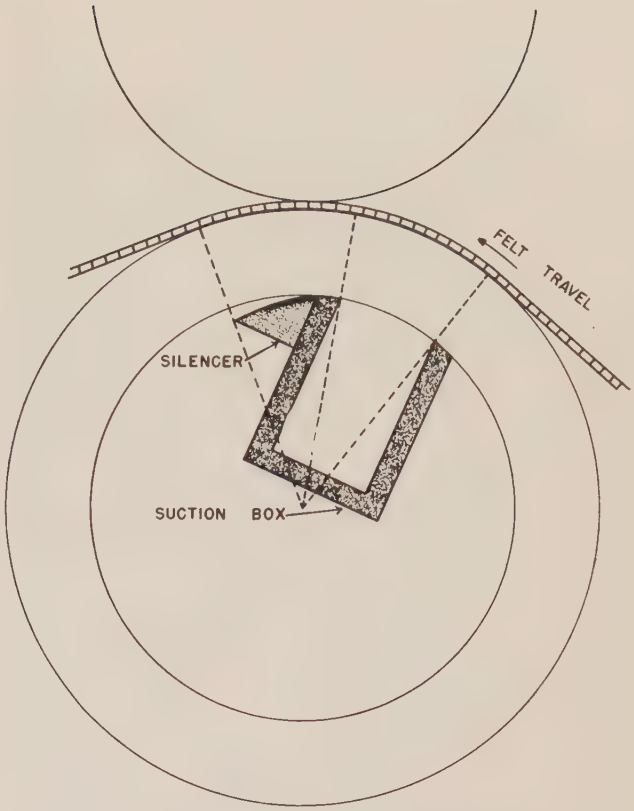

Fig. 5. Position of silencer in typical main press roll

Many different ways of silencing the experimental suction roll were tried, some of them with moderate success, but in no case was a silencer obtained which approached the 30 decibel reduction achieved by Abbott and Kraus. Therefore a return to their silencer was made and it was thoroughly investigated.

A continuously adjustable silencer of this kind was built. Figure 3 shows the adjustable silencer attached to the leaving packing of the suction box. The silencer is 2 inches long and rotates approximately about the line along which it joins the packing strip. It can be varied from a position against the inner surface of the shell to a gap of 0.085 inch at the outer end. Adjustment is made by means of screws operated from within the suction box, the turning of the screws being accomplished with a flexible shaft carried out through the vacuum line. An arrangement of this kind, which is described in the patent of Abbott and Kraus, does away with any necessity for predetermining or preadjusting the silencer gap, for the gap can be set while the suction roll is in operation.

A great deal of data were accumulated for wide ranges of speed, suction box position, felt wrap, and gap opening. Figure 4 is a plot of loudness against speed for the typical mill operating conditions of suction box position and felt wrap shown in Fig. 5. Five silencer positions are shown here. It is clear that the noise from a suction roll can be virtually eliminated by a proper choice of gap opening. There is an appropriate gap position such that at any speed the loudness is brought almost to the background loudness. The background loudness here is the loudness measured with the vacuum turned off.

It is essential that the silencer be covered with the felt (or with the wire and sheet in the case of a suction couch roll) in order that the flow of air into the holes of the shell may be controlled with the silencer. An illustration of what occurs when this is not done is shown in Fig. 6 which gives data for felt wrap and suction box position in the typical wringer-wrap of Fig. 7. In this case the felt leaves the suction roll before it passes over that part beneath which the silencer lies. The silencing is in no way comparable to that obtained when the silencer is covered. If the suction box is rotated toward the entering side of the nip in Fig. 7, the covering of the silencer will bring about silencing

The experiments described above reveal that the Abbott-Kraus silencer is remarkably effective in eliminating the noise from suction rolls. However, the only data relating to varying gap size are from laboratory experiments, and it is essential that information about silencer gaps be obtained under operating conditions. Consequently an adjustable silencer for a full-size suction roll is now being designed and will be built jointly by the Beloit Iron Works and the Kimberly-Clark Corporation.

Meanwhile installations have been made with fixed gaps on eight of the Kimberly-Clark creped wadding machines. The gap size was chosen as 0.085 inch because this opening on the experimental silencer seemed to be about the upper limit of gap (the roll was beginning to get loud again) and it is desirable to make the opening as large as possible for a fixed installation so that wear will reduce rather than increase the noise as time passes. Eventually, of course, the silencer will wear so much that the gap will no longer be effective. It is hoped that this wear will be slow enough so that the roll will remain quiet between the periodic maintenance shutdowns of the machine. At these shutdowns the silencer can be readjusted.

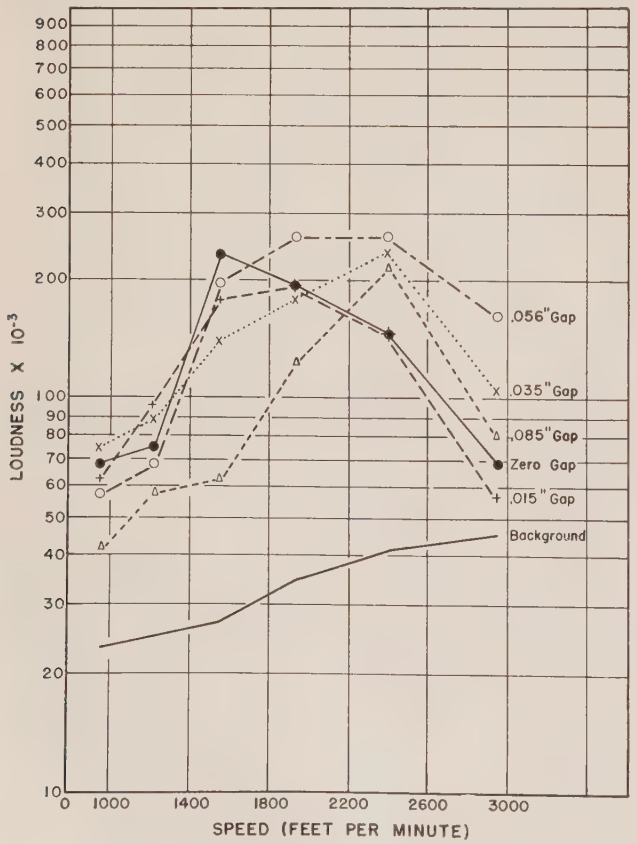

Fig. 6. Effect of gap opening on loudness (suction wringer wrap)

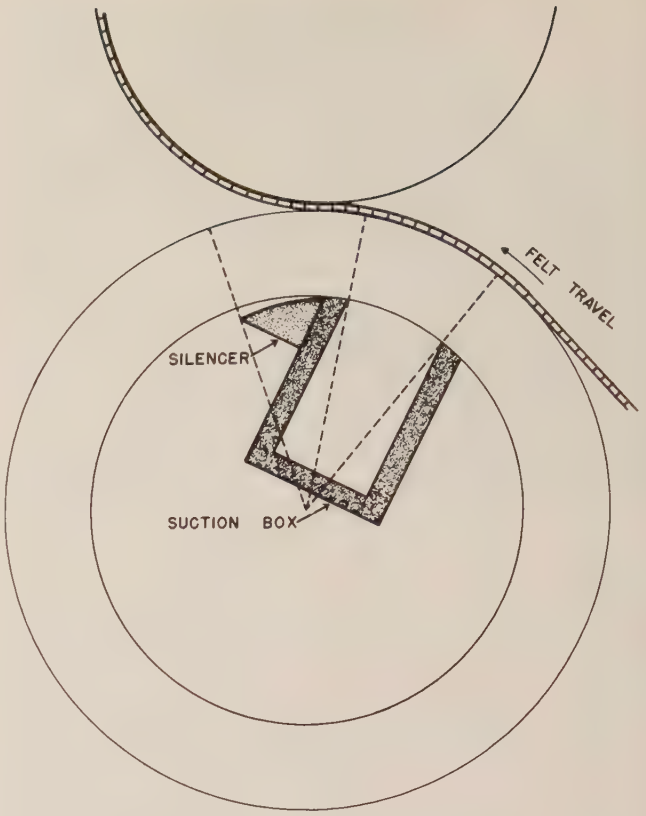

Fig. 7. Position of silencer in typical suction wringer roll

The technique used thus far on the eight machines which have had silencers of this kind put on them is laborious and expensive, but it has proved very effective. Steel templates which gave the proper silencer curve were made so that they could be laid across the packing strips of the suction box. The silencer material was bolted so that it fitted tightly against the packing strips, and it was then made to fit the template by sanding with a belt sander and by filing. On these installations no knowledge about tolerances was available, and, with one exception, extreme care was taken to make the silencers fit the templates as closely as possible. The exception occurred on one machine when time was not available for a careful job, and the rolls were replaced in the machine with a poorer fit on the silencers than on the other machines. This machine is not so quiet as the others.

The following data from two of the machines are typical of the installations which have been made. They are given because values made with the vacuum turned off are available for comparison.

Roll	*Loudness level before silencing,[a] decibels*	*Loudness level after silencing With vacuum,[a] decibels*	*Loudness level after silencing Without vacuum, decibels*	*Loudness reduction, %*
1	108 (16)	99 (16)	96	55
2	104 (15)	98 (18)	96	41
3	107 (6)	98 (19)	97	55
4	115 (14)	97 (17)	95	80
5	122 (14)	98 (17)	96	89

[a] Numbers in parenthesis refer to vacuum levels in inches of mercury.

The last column expresses the sound reduction in absolute loudness units rather than in units of loudness level. A reduction of 8 decibels in loudness level is about equivalent to a 50% reduction in loudness. The important data are those in columns 3 and 4 which show loudness levels with vacuum on and with vacuum off. The average difference is only 2 decibels, a just-noticeable difference. A well-trained ear can detect 1 decibel difference, but 3 decibels is a more commonly used value for noticeable differences.

It should be reemphasized that close attention to the position of the suction box within the roll shell is necessary for maximum quieting. The range of suction box positions over which a creped wadding machine can be made to operate satisfactorily is larger than the range over which it will operate quietly as well. There have been numerous instances since the recent installations in the Kimberly-Clark mills in which reductions in loudness of as much as 60% have been obtained on particular rolls merely by changing the position of the suction box.

The length of time for which these silencers will continue to quiet the suction rolls is still unknown. At this writing one of these machines has been in operation for more than three months after being quieted, and it is still quiet.

It has been definitely established that the Abbott-Kraus silencer can be made to work on creped wadding machines if it is carefully installed. While conditions on paper machines are different, there is every reason to believe that it will work equally well on them. The failure of this silencer in the intervening years between 1937 and the present has shown that considerable care is required both in installation and operation of the suction roll in order to make the roll run with least noise. In the past modifications in the design and mounting of the silencer, while seeming to be slight and intended to make installation and maintenance easier, have worked in the other direction. Successfully silenced rolls undoubtedly existed, but these would easily have been masked by other rolls in close proximity, especially in Kimberly-Clark mills where it is common practice to run two creped wadding machines side by side.

Whether the silencer in its present fixed-gap form is the final solution to the suction roll noise problem is as yet unknown, and only a long mill trial period will determine this. But even if the fixed-gap silencer is not the complete answer it seems certain that modifications (such as, for example, an adjustable gap) can be devised which will eventually make the noisy suction roll a thing of the past.

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Water-Resistant Starch Pastes

EDWARD H. HILL and VALENTINE X. SLIWINSKI

The need of water-resistant pastes for paper containers of all kinds is outlined. Investigations with different materials needed to give water resistance are listed. From these it is concluded that the degree of water resistance is in inverse proportion to the amount of starch conversion. Data are presented showing that the best type of water-resistant paste from the standpoint of pot life, machine operation, etc., is made by cooking a resin with starch and/or dextrine at a temperature around 195°F. and a pH betweent 5.0 and 6.0 with two plasticizers, such as a neutral salt and a hydrogenated vegetable fat.

The effect of formaldehyde on increasing water resistance of starch has been known for over 50 years. The improved effects of a combination of urea and formaldehyde have been known for some time. The synthetic resin manufacturers have shown outstanding improvements from time to time in the stability and effectiveness of their products. Even with these improvements, the starch and resin manufacturers have not been able to show definitely the chemical reaction which results in the water resistance of a paste made by mixing starch or a starch derivative with a urea-formaldehyde resin and treating the mixture under certain conditions to secure the best results.

It is not the purpose of this paper to give specific examples of how water-resistant pastes can be made or used. However, they are being used for making multiwalled bags, both small and large, and containers of many types which are used for packing chemicals, fertilizers, sugars, potatoes, fruits, etc. Within the last few years many multiwalled plants have gone over from regular to water-resistant paste for their entire output. It is believed that it is only a matter of a short time before this will be the case in practically all converting plants.

Water-resistant paste is a general term and is usually explained in different degrees. For comparison of different pastes it has been found that the time for a strip of paper submerged in water to pull apart at the seam will indicate, in a fair way, its degree of water resistance. To make this test, a strip of paper 1 inch wide, with a pasted cross seam, is suspended in a column of water held at 70°F. A 100-gram weight is attached to the lower end of the suspended strip. This is done so there will be a dead weight pull on the pasted seam at all times. The value of a paste, from the water-resistant standpoint, is in proportion to the amount of fibers pulled when the pasted seam has been soaked in water for 24 hours or more. If a pasted seam will pull fibers after soaking 24 hours, the same seam will hold together several weeks when suspended in water with an attached dead weight. The comparison between pastes given in the tables that follow show

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Table I. Effect of Varying Cooking Temperature

Cooking temperature, °F.	140	150	170	180	190	195
Cook No.	1	2	3	4	5	6
Thin boiling starch (No. 134), g.	100	100	100	100	100	100
U.F. resin, g.	5	5	5	5	5	5
Salt (NaCl), g.	5	5	5	5	5	5
Water, g.	450	450	450	450	450	450
pH cooked paste	5.6	5.9	6.1	6.2	6.3	6.5
Pot life	Good	Good	Good	Good	Fair	Fair
Suspended time, min.	15	19	21	24	340	Over 2 weeks

Note: Paste from cook 6 was rated as fair when soaked in water for 24 hr. and pulled apart by hand.

water resistance for the soaked samples as good, fair, and poor. Those that pull fibers across the entire pasted seam are listed as good; those pulling about 50% fibers are listed as fair, and those pulling less than 50% fibers are listed as poor.

The soaking water plays a big part in the water resistance of different pastes. Taft, in his paper, "The Use of Urea-Formaldehyde Resin for Waterproofing

Table II. Effect of Varying Cooking Time. Temperature 195°F.

Cooking time, min.	0	15	30	60	120	300
Cook No.	7	8	9	10	11	12
Thin boiling starch (No. 134), g.	100	100	100	100	100	100
U. F. resin, g.	10	10	10	10	10	10
Salt (NaCl), g.	5	5	5	5	5	5
Water, g.	450	450	450	450	450	450
Pot life	Fair	Fair	Poor	Very poor	Very poor	Very poor

Note: Hot water was added as required to pastes while cooking to keep concentration constant.
Paste from cooks 7 and 8 showed fair pot life and were workable after standing 48 hr.
Paste from cook 9 set up after 24 hr.
Paste from cooks 10, 11, and 12 set up on cooling.
The longer the cook the quicker the setup.

Starch Used in Corrugated and Solid Paperboard Production," points out that if there is not too much waterproofing of the dextrine and the boxes are soaked in distilled water, tap water, and sea water, three entirely different results may be noted. The sample soaked in sea water may show no ply separation and the sample soaked in distilled water may show complete ply separation, while that soaked in tap water

Table III. Effect of Different Plasticizers and pH Adjustment

Varied factor	*Without salt*	*With salt*	*With fat*	*Adding resin after cook*	*With soap*
Cook No.	13	14	15	16	17
Thin boiling starch (No. 134), g.	100	100	100	100	100
U.F. resin, g.	10	10	10	10	10
Salt (NaCl), g.	0	5	5	5	0
Soap, g.	0	0	0	0	0.5
Fat, g.	0	0	1	0	0
Water, g.	450	450	450	450	450
pH cooked paste	6.7	6.4	6.7	5.9	4.4
Pot life	Poor	Fair	Good	Fair	Poor
Water resistance	Good	Good	Good	Poor	Good

Note: All samples cooked to 195°F. and held there 15 min. before cooling.
Resin added to cook 16 after the cooked starch had been cooled to 150°F.
After the paste for cook 17 had cooled to 130°F. 1.0% alum (based on starch weight) was added to drop the pH down to 4.4.
Fat was a hydrogenated vegetable product.

Table IV. Effect of Salt Concentration

Salt used, %	0	5	10	15
Cook No.	18	19	20	21
Dextrine (No. 234), g.	300	300	300	300
U.F. resin, g.	30	30	30	30
Salt (NaCl), g.	0	15	30	45
Fat, g.	3	3	3	3
Water, g.	450	450	450	450
pH before cook	4.7	4.7	4.9	4.9
pH after cook	5.5	5.4	5.5	5.5
pH after 24 hr.	5.5	5.5	5.5	5.5
pH after 48 hr.	5.7	5.5	5.5	5.5
Pot life	Fair	Good	Good	Good
Water resistance	Fair	Fair	Fair	Fair

Note: Did not get as good water resistance for any dextrine as from thin boiling or thick boiling starch.
The paste from cook 21 was thinner than from cook 19, but this did not seem to be an advantage from the standpoint of tack and water resistance.

may show intermediate results. This unusual phenomenon can be the basis for lengthy discussions.

Data presented in this report were based on samples cooked under the following conditions, unless specified otherwise:

1. Samples cooked on steam bath with normal agitation during the cooking period.
2. Samples brought to 195°F. in about 20 minutes.
3. Samples held near 195°F. for 15 minutes, then cooled in water bath.

Table V. Effect of pH Adjustment

Adjusted factor	*No pH adjusted*	*Adjusted before cook to 5.4*	*Adjusted after cook to 5.5*	*Adjusted before cook to 4.5*	*Adjusted after cook to 4.5*
Cook No.	22	23	24	25	26
Thin boiling starch (No. 134), g.	100	100	100	100	100
U. F. resin g.	10	10	10	10	10
Salt (NaCl), g.	5	5	5	5	5
Alum, g.	0	0.2	0.2	0.6	0.5
Water, g.	450	450	450	450	450
pH finished paste	6.4	6.2	5.5	4.7	4.5
Pot life	Fair	Poor	Fair	Poor	Poor
Water resistance	Good	Good	Good	Good	Good

Note: Paste in cook 25 very thick during first part of cook. Thinned out near end of cooking period. pH was adjusted, where indicated, with alum.

4. A urea-formaldehyde resin sold on the market was used.
5. pH tests were made on the samples with a Coleman Instrument, model 3-D.
6. pH readings were made on samples after they had been cooled to room temperature, and pH adjustments were made with papermakers alum.
7. The water-resistant samples were prepared by

Table VI. Effect of pH Adjustment on Combination Paste

Adjusted factor	*No pH adjusted*	*Adjusted before cook to 5.2*	*Adjusted after cook to 5.4*	*Adjusted before cook to 5.5*	*Adjusted after cook to 5.5*
Cook No.	27	28	29	30	31
Thin boiling starch (No. 134), g.	50	50	50	0	0
Gum (No. 167), g.	50	50	50	200	200
U.F. resin, g.	10	10	10	20	20
Salt (NaCl), g.	5	5	5	10	10
Alum, g.	0	0.2	0.2	0.2	0.2
Water, g.	315	315	315	415	415
pH finished paste	6.1	5.5	5.4	5.7	5.5
Pot life	Fair	Poor	Fair	Fair	Fair
Water Resistance	Good	Good	Good	Fair	Fair

Note: Paste from cook 27 had good water resistance and fair pot life. This shows that it is not necessary to drop the pH if salt is cooked along with the U.F. resin and starch or dextrine, to obtain good water resistance, but usually best results are obtained if pH is adjusted between 5.0 and 6.0 after the cook.

Table VIII. pH of Pastes of Varying Starch/Dextrine Composition

Kind of material	No. 134	No. 3603	No. 234	No. 3501	No. 3740	No. 167
Per cent cold soluble	...	4.0	8.0	10	18	25
Cook No.	32	33	34	35	36	37
Starch or dextrine, g.	100	200	300	160	300	250
U.F. resin, g.	10	20	30	16	30	25
Salt (NaCl), g.	5	10	15	8	15	12.5
Fat, g.	1	2	3	1.6	3	2.5
Water, g.	450	450	450	450	450	450
Pot life	Good	Good	Good	Good	Good	Good
pH before cooking	6.4	5.3	4.7	5.9	5.7	5.0
pH after cooking	6.7	5.9	5.4	6.0	5.7	5.4
pH after 24 hr.	7.0	5.9	5.5	6.1	5.7	5.5
pH after 48 hr.	7.0	6.0	5.5	6.1	5.7	5.4

Note: The pH of paste made from the above products cooked same as in cook No. 8, Table II, did not decrease on standing after cooking. Thin boiling starch (No. 134); dextrines (Nos. 234, 3603, 3740); gums (Nos. 167, 3501).

sticking strips of kraft, wet strength paper on both types together with the paste and allowing the pasted samples to age 5 days before testing. In some cases the samples were heated in an oven for 1 hour at 100°F. to shorten the aging period.

8. The samples were tested for water resistance by being soaked in water 24 hours, and then pulled apart by hand, or they were submerged in a column of water with a 100-gram weight attached to the submerged end of the strip. In the latter case the results were reported by the amount of time it took the pasted seam to come apart.

9. Tap water was used in making the pastes or for soaking, unless listed otherwise. Experience has shown that the kind of water used in making the pastes may play a big part in the results obtained. This point will be investigated further.

10. The fat used was a hydrogenated vegetable product, similar to that usually sold to paper mills as a defoaming agent.

The data given in the following tables show, it is believed, the pertinent points needed for making a suitable water-resistant paste that will meet present-day requirements:

SUMMARY

From the foregoing data it is believed that the following points were demonstrated by this study:

1. To obtain the maximum water resistance from a paste made from starch and/or dextrine and U.F. resin, it is necessary to cook to a temperature between 190 and 200°F.

2. The addition of salt to a paste before cooking increases pot life. This, however, is not sufficient for the best type of pot life.

3. The best water-resistant paste was made by cooking at 195°F. for 15 minutes; longer cooking had a detrimental effect on the pot life.

4. Cooking 0.5% neutral soap, based on weight of starch, with the U.F. resin and starch and adjusting the pH with alum after cooling gave a paste with good water resistance but poor pot life, after pH was adjusted to 4.4 with alum.

Table VIII. pH of Paste at Different Temperatures During Cooking Period. Using Salt and Ammonium Chloride Added Before Cooking

Kind of water	Distilled	Tap	Distilled	Tap
Cook No.	38	39	40	41
Dextrine (No. 3740), g.	18.5	18.5	140	140
Thin boiling starch (No. 134), g.	110	110	58	58
U.F. resin, g.	16.5	16.5	23	23
Salt (NaCl), g.	6.5	6.5	0	0
Fat, g.	1.4	1.4	0	0
Ammonium chloride, g.	0	0	7.3	7.3
Water, g.	450	450	450	450
pH before cook	5.1	6.2	5.7	6.2
pH at 150°F.	5.5	6.3	6.1	6.3
pH at 170°F.	5.7	6.4	6.0	6.1
pH at 180°F	5.9	6.5	5.8	6.0
pH at 190°F.	6.1	6.5	5.4	5.5
pH end of cook	6.2	6.7	4.0	4.4

Note: A sample of the paste was taken out of the cooker at the different temperatures, cooled in a water bath, and tested for pH when samples were cool enough.

5. To secure maximum water resistance from U.F. resin, it was found necessary to cook it with the starch or dextrine.

6. The addition of 5.0% salt, based on the starch or dextrine weight, before cooking aids pot life. More than this amount does not seem helpful.

7. Adjusting the pH of paste before or after cooking (to a pH near 4.5) destroys most of the pot life. The pH should be adjusted between 5.0 and 6.0 after cooking.

8. Cooking thin boiling starch or dextrines of different solubilities with U.F. resin, salt, and 1.0% fat will give a pH just as high or higher at the end of the cook than it was before cooking. This pH will not decrease after standing for as long as 48 hours.

9. Cooking thin boiling starch and dextrine with U.F. resin and ammonium chloride will decrease the pH of the paste after it passes 180°F. during the cooking stage.

10. Best results are in most cases obtained when a study is made of the type of paper, kind of machine, use for the containers, etc., and a paste prepared for each individual job. It is believed, however, that the maximum water-resistant values from a certain amount of U.F. resin will be obtained if cooked to 195°F. with thin boiling starch, a small amount of salt, and about 1.0% hydrogenated vegetable fat and, if necessary, adjust the pH between 5.0 and 6.0. The tack of a paste can be improved by substituting dextrine for a part of the thin boiling starch or thick boiling starch. This, however, will decrease the water resistance of the paste in proportion to the amount of replacement by the dextrine.

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A Mold with a High Resistance to Organomercurials

Penicillium Roqueforti *Thom*

JOHN W. APPLING, STANLEY J. BUCKMAN, and ROBERT N. MEALS

The only surviving mold in groundwood pulp treated with phenylmercuric acetate was identified as *Penicillium roqueforti* Thom. It is suggested that this mold may be a fairly common one in Scandinavian pulp mills and also that it may be one of the unidentified species of *Penicillium* frequently observed in pulp and slime samples of the United States and Canada. The inhibiting concentration of phenylmercuric acetate in malt agar was about 8 p.p.m. for this mold, a value about four times that obtained for *Aspergillus niger*. For sodium pentachlorophenate in malt agar, the inhibiting concentration was about 40 to 60% less than for *A. niger*. The growth pattern below the inhibiting concentration was normal for the second toxicant but abnormal for phenylmercuric acetate. Chemical analyses of uninoculated controls of groundwood pulp mats with and without added nutrients were compared with those of similar mats which had been subjected during nine weeks to the action of *P. roqueforti*. Changes were of such small magnitude, even in the presence of added nutrients which greatly stimulated growth, that it was concluded they would not measurably affect the usefulness of the pulp.

In a recent paper by one of the authors (*2*) mention was made of a resistant species of *Penicillium* which was observed growing on groundwood pulp treated with high concentrations of phenylmercuric acetate. Since a review of the literature indicated that the same or a similar organism had been observed a number of times previously, it seemed of interest to identify the organism and to obtain further information about its resistance to toxicants as well as its effect on wood pulp. This paper presents the additional information which has been assembled.

IDENTITY OF THE MOLD

Repeated isolations from the groundwood pulp, which contained a high concentration of phenylmercuric acetate, yielded what appeared to be pure cultures of a species of *Penicillium*. One of these cultures was sent to Dr. Kenneth W. Raper, Northern Regional Research Laboratory, U. S. Department of Agriculture, Peoria, Ill., and another to Dr. Johanna Westerdijk, Director of the Centraalbureau voor Schimmelkulture, Baarn, Holland, for identification. Dr. Raper reported that the organism could best be assigned to the *P. roqueforti* series and Dr. Westerdijk identified it as *P. roqueforti* Thom.

Continued observation of various isolates later indicated the possibility of a mixed culture and repeated isolations finally yielded two cultures with different gross characteristics. One produced a large number of spores in a few days which resulted in a typical olive green appearance whereas the other produced an abundant white mycelial growth with very few spores. The two cultures were sent to Dr. Clyde M. Christensen, Division of Plant Pathology and Botany, College of Agriculture, University of Minnesota, St. Paul, Minn., and to Dr. Johanna Westerdijk. Dr. Christensen and Dr. Westerdijk both reported that the two appeared to be different strains of *P. roqueforti* Thom.

RESISTANCE TO TOXICANTS

The inhibiting concentration of a toxicant in malt agar medium was selected as the criterion for measuring the resistance of the species under investigation. The test method used was that described by Appling and McCoy (*1*) for determining the inhibiting concentration of various toxicants for *Aspergillus niger* van Tieghem.

Determinations were made of the inhibiting concentrations of phenylmercuric acetate (recrystallized grade) and sodium pentachlorophenate (technical grade known as Dowicide G) for the two strains of *P. roqueforti* and *A. niger*. Malt agar–toxicant plates were prepared in triplicate for each concentration of toxicant. For phenylmercuric acetate the range of concentrations was 0.5 to 15 p.p.m. using an increment of 0.5 p.p.m. up to 2 p.p.m. and one of 1 p.p.m. through the rest of the range. In the case of sodium pentachlorophenate, the range of concentrations was 4 to 60 p.p.m. using an increment of 4 p.p.m. The toxicants used had no effect upon the pH of the malt agar within the range of concentrations employed, and the pH was 5.4.

The cultures used as inocula for the malt agar–toxicant plates were grown on malt agar. The strains of *P. roqueforti* were ten-day-old cultures and the *A. niger* was a seven-day-old culture. Suspensions of each were prepared as described by Appling and McCoy (*1*). One of the triplicate series of malt agar–toxicant plates was inoculated with the green strain of *P. roqueforti*, another series with the white strain of *P. roqueforti*, and the third series with *A. niger*. Each plate was inoculated at three approximately equidistant spots using a loopful of suspension for each spot. The plates were incubated at 30°C.

Observations of all plates were made after 7 and 14 days of incubation. The data have been summarized in Table I. It is interesting to note the stimulated growth of both strains of *P. roqueforti* in the presence of 1.5 to 7 p.p.m. of phenylmercuric acetate as compared with the plates containing no toxicant and with those containing only 0.5 p.p.m. of the organomercurial. Growth of the two strains ceased with unusual abruptness between 7 and 8 p.p.m. The remarkable extent of growth is exemplified by a photograph of the plates containing 6 p.p.m. of phenylmer-

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Table I. Growth of Three Molds on Malt Agar Containing Two Different Toxicants

Mold	Growth[a] at concentration shown of phenylmercuric acetate, p.p.m.										
	0	0.5	1.0	1.5	2	3	4	5	6	7	8–15
Aspergillus niger	4+	3+	2+	1+	0	0	0	0	0	0	0
Penicillium roqueforti (green strain)	4+	4+	6+	6+	6+	6+	6+	6+	6+	6+	0
Penicillium roqueforti (white strain)	4+	4+	4+	6+	6+	6+	6+	5+	5+	5+	0

Mold	Growth[a] at concentration shown of sodium pentachlorophenate, p.p.m.										
	0	4	8	12	16	20	24	28	32	36	40–60
Aspergillus niger	4+	4+	3+	2+	1+	0	0	0	0	0	0
Penicillium roqueforti (green strain)	4+	4+	3+	0	0	0	0	0	0	0	0
Penicillium roqueforti (white strain)	4+	3+	0	0	0	0	0	0	0	0	0

[a] The results are expressed as 0 for no growth and 1+ to 6+ for increasing amounts of growth.

curic acetate. This photograph is shown as Fig. 1, where the green strain is designated as 1 and the white strain as 2. The inhibiting concentrations of phenylmercuric acetate were about 8 p.p.m. for both strains of *P. roqueforti* and about 2 p.p.m. for *A. niger*. Thus, the two strains of *P. roqueforti* were about four times more resistant than *A. niger* to phenylmercuric acetate. In contrast, the inhibiting concentrations of sodium pentachlorophenate were about 12 p.p.m. for the green strain; about 8 p.p.m. for the white strain; and about 20 p.p.m. for *A. niger*. In this case the two strains of *P. roqueforti* were approximately 40 to 60% less resistant than *A. niger*.

EFFECT ON GROUNDWOOD PULP

Since *P. roqueforti* Thom was observed growing on preserved groundwood pulp, it became highly desirable to determine the effect of this growth upon the pulp itself. The authors decided to subject sterilized groundwood pulp to the action of this mold for a period of time and to examine by chemical methods both inoculated and uninoculated portions of pulp.

Fig. 1. Photograph of green strain (1) and white strain (2) of* Penicillium roqueforti *Thom as found growing on malt agar containing 6 p.p.m. of phenylmercuric acetate

The pulp used was obtained several years previously from a Wisconsin groundwood mill. It had been preserved in an air-dried condition. Two series of circular mats were prepared from this groundwood pulp. Tap water was used to disintegrate the pulp in one series and tap water enriched by 0.2% of NH_4Cl and 0.02% of KH_2PO_4 in the second series. Sufficient slurry was filtered through a large Buchner funnel to produce circular mats containing 6.0 grams of air-dry pulp. The diameter of the mat was selected so that it would fit easily inside a standard Petri dish. Each mat was placed in a Petri dish and its weight was adjusted with tap water to contain approximately 50% moisture. It was then heated for 15 minutes at 121°C. in an autoclave to sterilize the pulp.

The sterilized mats were separated into five groups of ten each:

Group 1. Each of 10 mats without added NH_4Cl and KH_2PO_4 was placed over a three-day-old malt agar culture of *P. roqueforti*. The mat was allowed to contact the agar culture at several points but it was kept from complete contact by glass rods which had been placed in the melted agar.

Group 2. Each of 10 mats without added NH_4Cl and KH_2PO_4 was inoculated by spreading over its surface 1 milliliter of a spore suspension from a five-day-old malt agar culture of *P. roqueforti*. No agar was placed in the Petri dishes with the mats.

Group 3. Each of 10 mats with added NH_4Cl and KH_2PO_4 was inoculated as in group 2.

Group 4. Each of 10 mats without added NH_4Cl and KH_2PO_4 was kept for chemical analysis.

Group 5. Each of 10 mats with added NH_4Cl and KH_2PO_4 was kept for chemical analysis.

The mats in groups 1 to 3 were incubated at 30°C. To insure maintaining adequate moisture content to support the growth of *P. roqueforti* in the mats and to guard against contamination, rubber seals were placed around the edges of the dishes.

After nine weeks of incubation at 30°C., the mats in group 1 showed scattered growth on the upper side and some agar culture adhering to the lower side. Those in group 2 showed no growth. Those in group 3 (with added NH_4Cl and KH_2PO_4) showed heavy growth on the upper side and scattered growth on the lower side. At this point it was decided to terminate the incubation and to subject the various groups to chemical analysis. Group 2 was omitted since the mats showed no growth.

Seven mats from each group, excepting group 2, were dried at 105°C. to determine the moisture content and the dry weight of each mat. Those from group 1 gained 2.1% in weight during the incubation period probably due to the adherence of agar. Those from group 2, containing added NH_4Cl and KH_2PO_4, lost 5.5% of their original weight during the incubation period which the data indicate is a statistically significant loss.

The individual mats from each of groups 1, 3, 4, and 5 were combined into four composite samples, disintegrated in a Waring Blendor and air dried. The four composite samples then were stored in closed

jars from which portions were taken for analyses as required.

The analyses were run according to TAPPI Standards (*5*): T 201 m-46 (Cross and Bevan Cellulose), T 207 m-47 (Solubility in Hot and Cold Water), T 212 m-44 (Solubility in One Per Cent Caustic Soda Solution), and T 222 m-43 (Lignin). The results were calculated on the basis of the original dry weight of the mats. Thus, the average dry weight per mat in group 4 was determined to be 5.32 ± 0.02 grams and this value was used as the original average dry weight in computing the results of the analyses of group 1 as well as group 4. Similarly, for the mats containing added NH_4Cl and KH_2PO_4, the average dry weight per mat in group 5 was 5.37 ± 0.01 grams which value was used as the average dry weight per mat in group 3.

The results of the chemical analyses are summarized in Table II. These data show there was an increase in

Table II. Results of Chemical Analyses of Composite Samples of the Control Groups of Mats of Groundwood Pulp With and Without Added Nutrients and Mats of the Same Pulp Which Had Been Subjected to the Action of *Penicillium roqueforti* Thom for Nine Weeks

	Cold water soluble, %	*Hot water soluble,* %	*One per cent caustic soda soluble,*[a] %	*Lignin* %	*Cross and Bevan cellulose* %
Groups without added NH_4Cl and KH_2PO_4					
Group 4—Uninoculated control	0.6	1.8	15.1	28.1	61.8
Group 1—Inoculated	2.3	3.0	15.6	26.8	62.4
Groups with added NH_4Cl and KH_2PO_4					
Group 5—Uninoculated control	1.1	3.2	16.2	27.9	59.5
Group 3—Inoculated	2.3	4.8	17.3	27.7	53.2

[a] Not corrected for hot water solubility.

the cold and hot water soluble as the result of the action of *P. roqueforti*. The solubility in 1% caustic soda also was increased slightly with a parallel decrease in cellulose content of the pulp in the presence of added nutrients which greatly stimulated growth. However, all of the changes were of a relatively small magnitude and comparable to the results previously reported by Kress et al. (*3*), particularly when primary consideration is given to the pulp without added nutrients. It seems clear that the changes would have little or no bearing on the usefulness of the pulp. This is further supported by the following information previously reported by Rennerfelt (*4*) for pulp on which the same organism is believed to have been growing:

"In the treated pulp blueing fungi were entirely missing in all concentrations; moulds appeared as superficial discoloration in the lowest. On the other hand rot appeared in part of the samples. In pulp treated with 97 g. pulpasan (6 percent of ethylmercuric chloride) it covered about 95 percent of the sheets and gave the pulp a slightly reddish hue. In pulp treated with 240 g. pulpasan the rot appeared as isolated spots here and there on the sheets. The attack in the respective concentrations was of about the same extent as shown in pictures 2 and 3 in fig. 16. The two highest concentrations were entirely free from rot.

"Probably it is in this case a question of the same rotting fungus as was found in the pulp at the mills B and D. The occurrence, the colour and the appearance and size of the spots showed obvious similarities. A thing common to all three cases was that during continued storage the fungus had spread further in lower concentrations and also begun to appear where pulp was being treated with a concentration which was still satisfactory after a shorter storage time. This could also be observed in the pulp at mill F. After 6 months' storage slight violet shadings appeared at the edges of the sheets in bales also treated with 350 (and) 700 g. per ton (Bade 1940). All accordingly this fungus seems to have little influence upon the whiteness as well as on the strength of the pulp. According to analyses carried out of the Papirindustriens Forskningsinstitutt, Oslo, the tearing off length and the burst factor are of the same size with first-rate (and) decayed pulp."

SUMMARY AND CONCLUSIONS

Through the cooperation of three mycologists, the identification of the surviving mold in groundwood pulp treated with phenylmercuric acetate was established as *P. roqueforti* Thom. Although this species has not been previously identified as a significant part of the microflora in groundwood pulp, references to an organism with similar general growth characteristics in Scandinavian pulps treated with other organomercurials suggests that *P. roqueforti* may be fairly common in those pulp mills. Also it may be some of the unidentified species of *Penicillium* which are quite frequently observed in pulp and slime samples in the United States and Canada.

The inhibiting concentration of phenylmercuric acetate in malt agar was about 8 p.p.m. for both strains of *P. roqueforti*. This value was about four times that obtained for *A. niger*. The growth pattern of a test organism in the range below the inhibiting concentration of a given toxicant is usually one of gradually decreasing amounts of growth. In the case of *P. roqueforti*, growth was actually greater in the range of 1.5 to 7 p.p.m. than it was below 1.5 p.p.m. and on malt agar containing no toxicant. Instead of gradually decreasing growth after 7 p.p.m., it suddenly ceased for no growth occurred at any higher concentrations. Thus the resistance of *P. roqueforti* to phenylmercuric acetate was high and growth continued unabated from 0.5 to 7 p.p.m. In sharp contrast, the resistance of *P. roqueforti* to sodium pentachlorophenate was lower than that of *A. niger*. Furthermore, the growth pattern was one of gradually decreasing amounts until the inhibiting concentration was reached. The resistance was much less to this toxicant than to phenylmercuric acetate.

Chemical analyses of composite samples from control groups of groundwood pulp mats with and without added nutrients were compared with those of similar mats which had been subjected during nine weeks to the action of *P. roqueforti*. Changes were of relatively small magnitude, particularly for the pulp to which no nutrients were added to stimulate growth. Since such condition is comparable to that involved in the normal storage of pulp, it was concluded that the growth of *P. roqueforti* would not measurably affect the usefulness of the pulp.

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Compounds Inhibiting the Sulphite Cook

HOLGER ERDTMAN

The possible reactions of lignin that inhibit the pulping of wood by the conventional sulphite process are presented. Phenol compounds have been extracted which are apparently the cause of the indigestibility of wood and function as connecting links between the large lignin molecules.

It is an old experience that certain woods cannot be properly delignified by the usual sulphite method. Pine heartwood is a well-known example. The sapwood, however, can be digested easily. For a long time, it was supposed that there might be some relationship between burnt cooks and the nondigestibility of pine heartwood.

However, it was generally assumed that the nondigestibility of pine heartwood is the result of its great content of resins. These were thought to block the impregnation of the chips with cooking acid. It is a fact, however, that pine sapwood sometimes contains more resin than the heartwood and that sprucewood, when impregnated artificially with large amounts of rosin, can be properly pulped.

It is also a well-known fact that wood rich in certain tannins cannot be pulped. All tannins, however, do not prevent the digestibility. For example, redwood is rich in tannin but nevertheless can be pulped normally. No one appears to have considered that there might be some relationship between the resin and tannin troubles until Hägglund and Schwalbe started their investigations of the cause of the nondigestibility of pine heartwood.

It was found that pine heartwood which has been carefully extracted with ether or benzene could not be pulped in spite of the removal of most of the resin. If, however, the ether- or benzene-extracted wood was subsequently extracted with alcohol or acetone, a small additional amount of resins was removed and the wood now could be pulped normally.

If sprucewood was impregnated with the ether-soluble resin, it still remained digestible. If sprucewood was impregnated with the acetone extract, however, it became nondigestible. Thus, the acetone extract must contain something which prevents normal pulping. This was very strange because the acetone extract only amounted to 1 to 2%, whereas the ether extract constitutes 5 to 10% and sometimes 20% of the weight of the wood. A still more puzzling observation was made. The acetone extract, which is composed of resins which cannot be removed by ether extraction, was found to be partly soluble in ether. This ether-soluble fraction of the acetone extract rendered sprucewood nondigestible. The ether-insoluble fraction of the acetone extract, however, was quite harmless.

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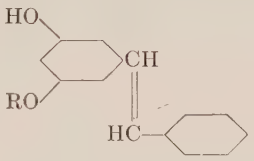
Hägglund suggested that the ether-soluble part might occur in the wood covered by ether-insoluble material. This would cause it to be nonextractable by ether. The alternative explanation—that the ether-soluble fraction of the acetone resin is strongly absorbed by the wood—could be disproved. Sprucewood was impregnated with this fraction. On extraction with ether, it could be removed easily.

From the ether-soluble part of the acetone extract, two new phenols were isolated and their structure



R = H—Pinosylvin
R = OMe—Pinosylvin methyl ether

elucidated. Pine heartwood contains up to about 3% of these phenols. Generally, however, the amount is only 0.8 to 1% and sometimes much less. Usually these phenols occur together in the proportion 1:3 to 1:4. Methods have been devised for the quantitative estimation of the sum of the phenols, as well as for each of them separately. The mechanism of the inhibition of the sulphite cook caused by these phenols has been extensively investigated.

Perhaps the most interesting point is the fact that the presence of such a small quantity of these phenols in the wood causes such a dramatic change in the digestibility of the wood. The same effect is obtained if other phenols are substituted for pinosylvin and experiments show that the effectiveness of inhibition parallels the condensability of the phenols with ketones and many other reagents. Instead of phenols, aromatic amines may be used; even *N*-substituted amines are active—e.g., $C_6H_5NMe_2$. Like phenols, anilines easily undergo condensation reactions in which the aromatic nucleus is substituted. Pyridine, which possesses a low reactivity, is inactive.

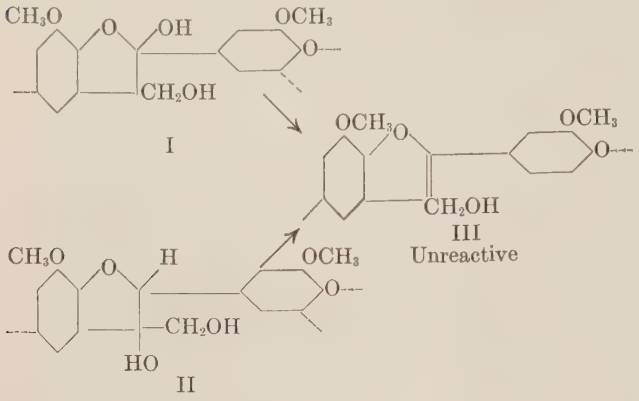
In order to understand the mode of action of these reagents when inhibiting the sulphite cook, some reactions characteristic of lignin should be recalled.

When heated to 135 to 140° in the presence of water, wood slowly becomes indigestible by sulphite cooking acid. Generally, the reaction is interpreted as a condensation process by which lignin molecules are linked together to form large complexes. The groups normally sulphonated are involved in this condensation process.

The nondigestibility of the wood is caused by the formation of these large molecules and the diminution of the number of groups capable of sulphonation. A low sulphonated, insoluble, lignin condensation product is formed in the wood. Exactly the same happens in the so-called burnt cook.

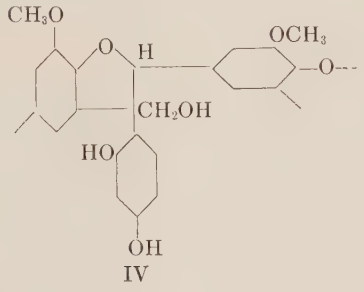
There is another reaction which can take place—namely, the extrusion of water molecules with formation of double bonds. On the basis of present specu-

lations on the structure of lignin, this could be interpreted in the following manner:

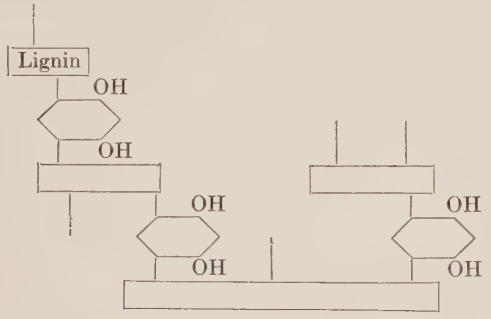


That would cause the formation of a nonreactive anhydro lignin (III).

If a phenol—e.g., resorcinol—reacts with a molecule of the structure indicated by II, one would expect the formation of the product IV.



If the phenol—e.g., resorcinol—contains more than one reactive position, the formation of two- or three-dimensional condensation products must be expected, as outlined in the following scheme:



This process is very similar to the formation of phenolic plastics. In this case, however, the phenol takes the place of the formaldehyde. It functions as the small molecule connecting the large lignin molecules. Only a very small amount of phenol is needed to cause the formation of very large, completely insoluble products.

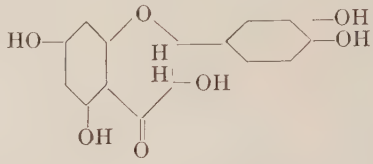
Like resorcinol, pinosylvin is a strong inhibitor of the sulphite digestion of wood.

Ordinary phenol is rather ineffective. The same applies to other monohydric phenols such as guaiacol and catechol and, fortunately, the phenolic groups in lignin itself. However, the residual lignin in rayon pulp, for example, may be a lignin-lignin condensation product. Also, gallic acid, a common constituent of many tannins, is not very reactive in inhibiting the sulphite cook.

Very strong inhibitors, in addition to those phenols already mentioned, include pyrogallol, phloroglucinol, the naphthols, and naphthoresorcinol. Catechin and tannins of a catechin type are inhibitory because of the phoroglucinol nucleus which they contain.

These results immediately explain why many tannin-containing woods cannot be completely pulped by the sulphite process. Examples are chestnut and quebracho.

All or almost all pines contain pinosylvin. In addition, many pine heartwoods contain other phenolic substances—especially flavones and flavanones belonging to the phloroglucinol series. Their heartwood, therefore, is unsuitable for sulphite pulping purposes. The heartwood of Douglas fir (*Pseudotsuga taxifolia*), according to Pew of the Forest Products Laboratory, contains a compound of the following structure:



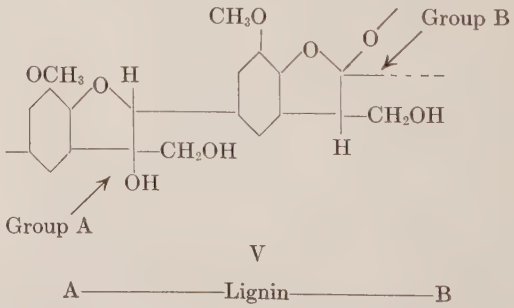
It is obviously the cause of the difficult pulpability of the heartwood of Douglas fir.

It appears safe to assume that all nondigestible woods will prove to contain substances which easily condense with lignin under acid conditions to form insoluble products, even after sulphonation.

If wood covered with bark containing inhibitory phenols—e.g., catechin-like tannins—is allowed to stand in contact with water for some time, the tannins migrate from the bark into the outer layer of the wood, rendering it nondigestible. This causes serious troubles in countries like Sweden, where most of the wood has to be floated from the forests to the mills.

Many inventors have tried to develop methods for pulping pine heartwood. Obviously, the wood could be extracted prior to cooking. However, that is not economically feasible. It would, of course, appear to be possible to block the reactive positions of pinosylvin prior to the sulphite cook. No such method, however, has been found which would not render the lignin insoluble.

Graham has devised a method of pulping pine heartwood in two steps. Pinewood is first heated with sodium sulphite solution which is slightly alkaline and then with ordinary acid cooking liquor. In this way



V

Group reacting with sulphite at any pH. Reacts with phenols below pH 3.5 but not above.

Group reacting with sulphite below pH 7 but not with phenols at any pH. Involved in the formation of acetal linkages between lignin molecules or between lignin and carbohydrates.

it is also possible to pulp sprucewood impregnated with reactive phenols—e.g., resorcinol or pinosylvin.

To explain this, the following theory, which has been substantiated by various experiments, was advanced.

Lignin is supposed to contain groups of different reactivity toward sulphite and phenols. Some of these groups react with sulphite *but not with phenols* under alkaline, neutral, or *very slightly acid* conditions to form an ordinary low sulphonated solid lignosulphonic acid. Other groups, obviously those involved in the hydrolysis and further sulphonation of the solid lignosulphonic acid, react readily with sulphite under acid conditions but not with phenols.

On the basis of the formulas discussed for lignin (e.g., V) we can differentiate two groups, A and B.

Much work on the behavior of model substances containing, for example, groups A and B, to sulphite and phenols will be needed to prove or disprove this theory. However, the assumption of groups of different reactivity in lignin seems necessary. This also appears to follow from studies on the stability of lignosulphonic acids to alkali. Part of the sulphonic acid groups are more easily removed from lignosulphonic acids than are the others.

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Heartwood Extractives of Conifers

Their Fungicidal and Insect-Repellent Properties and Taxonomic Interest

HOLGER ERDTMAN

The author directs attention to the chemistry of the conifers and its taxonomic interest and points out in which ways Nature herself has succeeded in meeting the dangers which threaten the dead heartwood from fungi and insects. The isolation and structural elucidation of the physiologically active heartwood constituents may become of direct technical interest or stimulate attempts to synthesize similar compounds of still greater technical importance as fungicides and insecticides and also attempts to apply genetic methods to the improvement of the racial properties of forest trees.

Pinosylvin, the inhibitor of the normal pulpability of the heartwood of Scotch pine, possesses a phenolic structure reminiscent of several antiseptic compounds —e.g., hexylresorcinol. This suggested that pinosylvin might be the main cause of the well-known great durability of pine heartwood.

Extensive studies by different specialists (especially by E. Rennerfelt of Stockholm) showed this to be true. Other factors contributing to the durability are dryness and lack of nutrients, such as sugar or starch. Not only are pinosylvin and pinosylvin monomethyl ether very toxic to bacteria and fungi, but they also possess great toxicity to fish and insects and to warm-blooded animals (e.g., mice).

This being established, it was of interest to investigate whether the durability of the heartwood of other species of the genus *Pinus* is due to the same cause. It was also of interest to extend the investigation to cover heartwoods of other conifers. These studies, which are still in their first stages, have already resulted in the isolation of a wealth of interesting heartwood constituents. Some of these are physiologically active, whereas some appear to lack biological importance. This does not mean that they lack interest. On the contrary, it is these compounds which possess an especially great taxonomic value. Taxonomists are very interested in properties of minor physiological importance because one has reason to assume that they are particularly conservative. They cause no harm and, therefore, have been handed down from species to species during their evolution without being changed to any considerable extent. There has been no need for a change. Small alterations, of course, may have occurred. From a chemical point of view an introduction of or a methylation of a hydroxyl group or even a dehydrogenation must be considered as minor changes. The main architecture is preserved, and the genetical relationships, therefore, are easily recognizable.

If we endeavor to employ chemical constituents as tracers in taxonomy, we should, therefore, pay little attention to the chemistry of highly specialized organs. We should consider substances of little or no physiological importance—"waste products," especially those which are "excreted" into dead tissues like bark and heartwood.

Pinosylvin occurs in the heartwood of Scotch pine deposited, obviously, inside ether-insoluble membranes. They can, therefore, normally not be directly extracted with ether. Extraction with this solvent, however, removes a great amount of terpenes and resin acids localized outside these membranes. This highly simplifies the isolation of many of the compounds in which we are at present interested. They are generally found in the ether-soluble part of the acetone extract of ether-extracted heartwood. This acetone extract also contains the membrane substances which may be recovered from, or at least constitute part of, the ether-insoluble portion of the acetone extract. They are probably related to the "native lignin" especially studied by F. Brauns.

The ether-soluble fraction of the acetone extract sometimes deposits crystals directly on evaporation of the ether. The complete segregation of the different components, however, generally is a difficult matter. No general methods can be devised to achieve this. Common operations include crystallizations from different solvents, extractions of the ether solutions with solutions of bicarbonates, carbonates, or alkali, steam distillation, and chromatography.

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When only small amounts of membrane substances are present, part of the components under consideration may be removed from the wood during the initial ether extraction. The isolation of the components from this ether extract is generally very difficult owing to the contamination with the large amounts of resinous products usually co-extracted.

The ratio of pinosylvin-pinosylvin monomethyl ether appears to be rather constant in Scotch pine (*Pinus silvestris*), usually being between 1:3 and 1:4. Pinosylvin, as a rule, is a stronger fungicide than its monomethyl ether. The dimethyl ether is inactive. Quite recently it has been found possible to demethylate pinosylvin monoethyl ether to pinosylvin in excellent yield (B. Lindberg).

As reactive phenols, pinosylvin and pinosylvin monoethyl ether couple with diazotized anilines to form azo dyes. Bisdiazotized benzidine yields a deep blood-red dye and constitutes a very convenient and sensitive reagent for these phenols. When treated with this reagent, pine sapwood is colored dull brown. The heartwood develops a strong blood-red color. This reaction may be used for an approximative colorimetric estimation of the fungicidal phenols in heartwood and has been applied to a large number of pine sections. The material—several thousand sections—has been collected from all over Sweden, from pines grown on all types of soil, and from all latitudes and altitudes.

The intensity of the color reaction varies considerably and no relations to soil quality or climatic conditions appear to exist. Some pines contain a heartwood with a high concentration of pinosylvin phenols in the periphery but with only a low concentration in the central part. Others have a more even distribution. Two pines growing side by side may possess heartwoods of a very different type and very different concentration of the preservatives. Therefore, it appears probable that the differences are due to racial factors.

Pines possessing a large proportion of heartwood with a high pinosylvin content and an even distribution should be selected for seed production provided that other properties are favorable. A pine which is considered to be an "elite tree" from its appearance only may contain an inferior heartwood. The colorimetric investigation of a heartwood sample is a matter of a few seconds and could easily be carried out in the forest by untrained personnel.

Pines (even "elite pines") with low concentration or uneven distribution of pinosylvin, yield timber easily attacked by fungi and insects and should be removed and used for the production of kraft pulp.

The formation and deposition of pinosylvin obviously is due to reactions initiated from the cambium. If this is injured, the heartwood formation stops exactly below the wound. The naked sapwood is easily attacked by fungi. The resin flow, however, provides a temporary protection. The tree is now able to meet the danger of infection by surrounding the threatened area by pinosylvin-containing tissues. So-called wound heartwood is slowly formed. The proportion of pinosylvin to pinosylvin monomethyl ether in such tissues has not yet been investigated.

Pinosylvin monomethyl ether has been isolated from pine heartwood which had been embedded in a peat bog more than 2000 years ago.

Pinosylvin and its mono- or dimethyl ether appear to be characteristic components of the heartwood of almost all pine species. These stilbene derivatives appear to be characteristic components for the genus *Pinus*. About 80 to 90 species of *Pinus* are known,

Table I. Heartwood Components of Pines

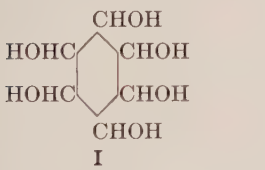
Species	*Pinitol*	*Arabinose*	*Pinosylvin*	*Pinosylvin monomethyl ether*	*Pinocembrin*	*Pinostrobin*	*Pinobanksin*	*Strobopinin*	*Chryptostrobin*	*Chrysin*	*Tectochrysin*	*Remarks*
						Haploxylon						
P. cembra	+	?	−	+	+	−	..	..	..	+	+	Very little tectochrysin
P. strobus	+	?	−	+	+	+	(+?)	+	+	+	+	
P. lambertiana	+	+	−	−	−	+	−	+	..	−	+	Plus one unidentified compound
P. monticola	+	+	−	+	..	..	..	(+?)	..	+	+	Investigation not finished
P. parviflora	+	..	−	+	+	..	..	..	..	..	..	Very incomplete investigation
						Diploxylon						
P. silvestris	−	+	+	+	−	−	−	−	−	−	−	
P. halepensis	−	−	+	+	−	−	−	−	−	−	−	
P. nigra	−	?	+	+	−	−	−	−	−	−	−	Some pinosylvin dimethyl ether
P. resinosa	−	−	−	+	−	−	−	−	−	−	−	Old wood sample
P. montana (mugo)	−	?	+	+	+	−	−	−	−	−	−	
P. pinea	−	+	−	+	+	−	−	−	−	−	−	
P. radiata	−	?	−	+	+	−	+	−	−	−	−	
P. banksiana	−	+	+	+	+	−	+	−	−	−	−	
P. contorta	−	?	+	+	+	−	+	−	−	−	−	
P. pinaster	−	+	−	−	+	..	−	..	..	−	−	Will be re-examined for pinosylvin phenols
P. ponderosa	−	?	+	+	−	−	+	−	−	−	−	
P. palustris	..	..	(+?)	(+?)	..	.	(+?)	..	..	..	..	Very incomplete investigation; some pinosylvin dimethyl ether; probably also pinosylvin monomethyl ether

Notes: ?, not carefully searched for. −, carefully searched for but not found. (+?), not certain.

many of which have still not been investigated. However, a fair number of the pines have already been studied, and the results are very interesting because they appear to show that it is possible to use heartwood components for taxonomic purposes.

Taxonomists recognize two main subgroups of pines —the haploxylon pines and the diploxylon pines. The haploxylon pines usually have five needles in each bundle. The diploxylon pines have two or three. Taxonomists also subdivide these groups into still smaller subgroups and it is interesting to find that there is reason to believe that it will ultimately be possible to check the system based on purely botanical evidence by the completely independent chemical study of the heartwood constituents. The heartwoods of all haploxylon pines hitherto investigated contain pinitol (**I**), a well-known constituent of the exudates of the sugar pine (*Pinus lambertiana*). Frequent components of these pines are flavones—e.g., chrysin (**II**) and tectochrysin (**III**). The corresponding flavanones (**IV** and **V**) which have been termed pinocembrin and pinostrobin, respectively, have also been isolated from the heartwood. Other components are stropopinin and cryptostrobin. Probably they are methylphloroglucinol analogs of pinocembrin. L-Arabinose has been found in several heartwoods belonging to the diploxylon series.

No pines belonging to the diploxylon group appear to be able to dehydrogenate pinocembrin and pinostrobin to the corresponding flavones (chrysin and tectochrysin). The flavanones, however, are frequently found in the diploxylon group. *Pinus banksiana* (jack pine) contains a peculiar hydroxy derivative called pinobanksin; this very probably possesses the structure **VI**. The same component occurs in *Pinus contorta* (lodgepole pine), which is botanically closely related to jack pine. Several such relations have been found and Table I gives the results of the investigations. This table is partly based on unpublished investigations of Dr. G. Lindstedt and other workers in the Royal Institute of Technology, Stockholm. When consulting this table, it must be remembered that only the actually isolated components are significant. Some components may have been overlooked because they only occur in a very small amount.



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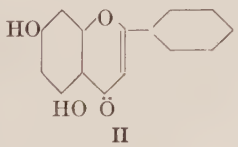

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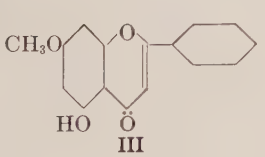

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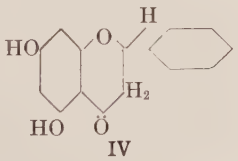

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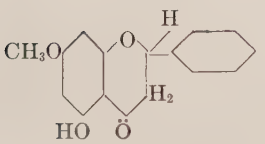

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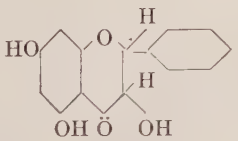

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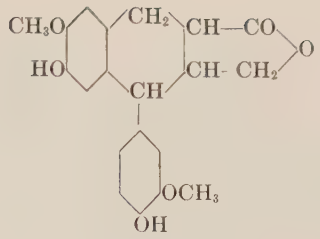

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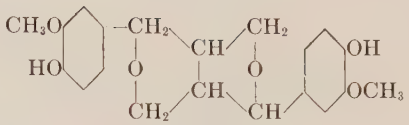
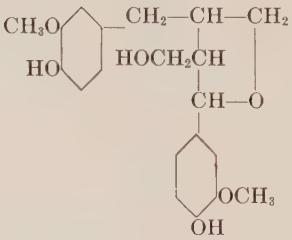


VIII



IX

The pines belong to the family *Pinaceae*, which also includes the genera *Picea, Tsuga, Pseudotsuga, Abies, Keteleeria, Larix,* and *Cedrus.*

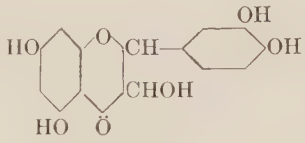
The nondurable heartwood of a series of spruce (*Picea*) species has been investigated. Several contained conidendrin (**VII**), also known under the name sulphite liquor lactone or tsugaresinol. This compound is nontoxic to fungi. It is a lignan closely related to pinoresinol (**VIII**) which occurs in the wound resins of many spruces. This is of interest because it indicates that normally the cambium produces conidendrin, or a progenitor of this compound, which is deposited in the heartwood. Under abnormal, pathological conditions, the metabolism appears to be changed and pinoresinol is produced. The same compound is formed from wounds of a number of pines. Pinoresinol, therefore, constitutes a chemical link between the pines and the spruces.

On the other hand, conidendrin also occurs in the wood of all *Tsuga* (hemlock) species investigated. Thus, conidendrin offers a link between *Picea* and *Tsuga.*

A compound very similar to pinoresinol occurs in the wound resins of the larches (*Larix*)—namely, lariciresinol (**IX**). Lariciresinol is a dihydropinoresinol and can be prepared from pinoresinol by catalytic reduction (R. D. Haworth). An isomerization product of lariciresinol, isolariciresinol, can be dehydrogenated to conidendrin. Since all these compounds are optically active, this series of reactions offers chemical and stereochemical evidence of the close relationship between *Picea, Pinus, Larix,* and *Tsuga.* The heartwoods of larches are durable. The cause is still unknown.

J. C. Pew recently isolated a flavanolone (**X**) from the heartwood of Douglas fir [*Pseudotsuga douglasii* (= *P. taxifolia* or *P. mucronata*)], which proved to be a dihydroxy derivative of pinobanksin (**VI**). This discovery relates *Pseudotsuga* to the pines. The name taxifolin has been proposed for this new flavanolone.

Pew showed that taxifolin can easily be dehydrogenated by air in acid solution with formation of quercetin (**XI**). On the other hand, quercetin could be hydrogenated to optically inactive taxifolin by means of sodium hydrosulphite. Reduction with zinc dust and hydrochloric acid afforded 3-deshydroxytaxifolin (**XII**), identical with the long-known flavanone, eriodictyol. This beautiful work provides important information as to the genetic relations between flavones and flavanones.



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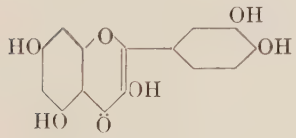
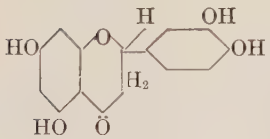


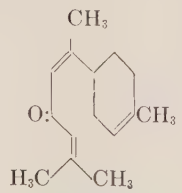
XI



XII

The heartwood of the true firs (*Abies*) is not durable and no fungicidal compounds have been isolated from *Abies* wood. *Keteleeria* has not yet been investigated. The *Cedrus* species *deodara* and *atlantica* (Himalayan and atlas cedar) have been subjected to chemical investigations. All *Cedrus* species possess very durable heartwoods. The cause is not known but a peculiar compound, atlantone (a sesquiterpene ketone), has been isolated from the wood of *C. deodara* and *atlantica*. It probably possesses the structure (**XIII**) and can be hydrolyzed into two molecules of acetone and one of *p*-methyl-Δ^3-tetrahydroacetophenone. The potential antibotic properties of atlantone appear not to have been investigated. This question is now being studied.

The family *Pinaceae* seems to be characterized by the preferential production of phenolic compounds, stilbenes, flavones, flavanones, and flavanolones in the heartwood. The genus *Cedrus* is perhaps exceptional, but no careful investigation of the heartwood of the true cedars appears to have been carried out and a re-examination of the chemistry of these heartwoods may well disclose the occurrence of other components than atlantone (which has been obtained simply by distillation).



XIII

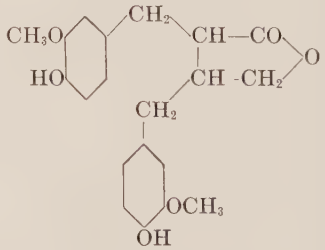
The interrelations between the different genera of the family *Pinaceae* may be summarized in the following way.

	Pinus						
	Picea	*Haploxylon*	*Diploxylon*	*Tsuga*	*Larix*	*Pseudotsuga*	*Cedrus Abies Keteleeria*
Lignans							
Conidendrin	+	..	..	+			
Pinoresinol	+	..	+				
Lariciresinol	..	..	..	..	+		
Pinitol	..	+					
Arabinose	..	(+?)	+				
Stilbenes	..	+	+				
Flavones	..	+					
Flavanones	..	+	+	..	..	+	
Atlantone	..	..	..	..	..	..	+

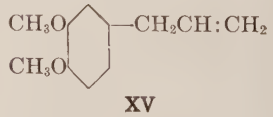
Thus we still lack interrelations between the genera *Cedrus, Abies,* and *Keteleeria* and the other genera of the family *Pinaceae.*

The family *Podocarpaceae* is an interesting one to which several genera belong—e.g., *Podocarpus, Dacrydium, Microcachrys, Saxegothaea, Pherosphaera,* and *Phyllocladus.* Almost all trees belonging to this family inhabit the southern hemisphere. Unfortunately, very little is known about the chemistry of their heartwoods.

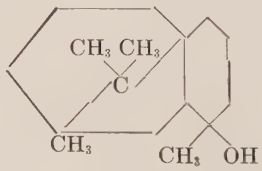
Many heartwoods of the genus *Podocarpus* are very durable and probably contain toxic components. The wood of *Podocarpus spicatus* (matai) sometimes contains a resinous exudate from which a lignan called matairesinol (**XIV**) has been isolated. It is interesting that the same exudate also contains conidendrin (**VII**). Obviously, *Podocarpus spicatus* is able to dehydrogenate matairesinol to conidendrin. A similar transformation of the "open" lignan matairesinol to the cyclicized phenylnaphthalene derivative can be carried out with lead tetraacetate. *Podocarpus spicatus* also contains quercetin (**XI**) (private communication from L. H. Briggs, Auckland, New Zealand). These results may indicate that the genus *Podocarpus* has some relation to the *Pinaceae* family. In one species of the genus *Dacrydium* (*D. franklini* Hook), eugenol methyl ether (**XV**) has been found to be the main component of the wood oil. Methyleugenol, of course, is closely related to the lignans. Some *Dacrydium* species also contain the sesquiterpene alcohol, cedrol (probably **XVI**).



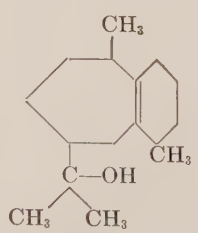
XIV



XV



XVI



XVII

Very little is known about the chemistry of the genera *Agathis* and *Araucaria* of the family *Araucariaceae*. They yield "resin acids" to which various compositions have been assigned. The wood resins of these trees, therefore, deserve further investigations.

In spite of the fact that many trees of great economical importance belong to the *Taxodiaceae* family, we are very little informed about the chemistry of their heartwoods which, generally, are characterized by an extreme durability. To the *Taxodiaceae* belong the genera *Sciadopitys, Cunninghamia, Sequoia, Metasequoia, Cryptomeria, Athrotaxis, Taiwania, Taxodium,* and *Glyptostrobus.*

The heartwood of redwood (*Sequoia sempervirens*) contains large amounts of amorphous tannins, apparently catechol derivatives. Some crystalline compounds have been isolated—e.g., sequoyin (which evidently is a phenolic compound), sequoyit (a meso-inositol monomethyl ether), and pinitol (a monomethyl ether of *d*-inositol). The occurrence of phenolic compounds has been reported from the genera *Athrotaxis* and *Cryptomeria. Cunninghamia* contains cedrol.

The family *Cupressaceae* is far better known chemically. To this family belong the genera *Actinostrobus, Callitris, Callitropsis, Fitzroya, Thujopsis, Libocedrus, Thuja, Biota, Cupressus, Chamaecyparis, Fokienia,* and *Juniperus.* The heartwood components of this family, as a rule, appear to be related to terpenes, although a few phenols are known. Even these sometimes are related to terpenes (carvacrol, hydrothymoquinone) but one is a lignan (hinokinin).

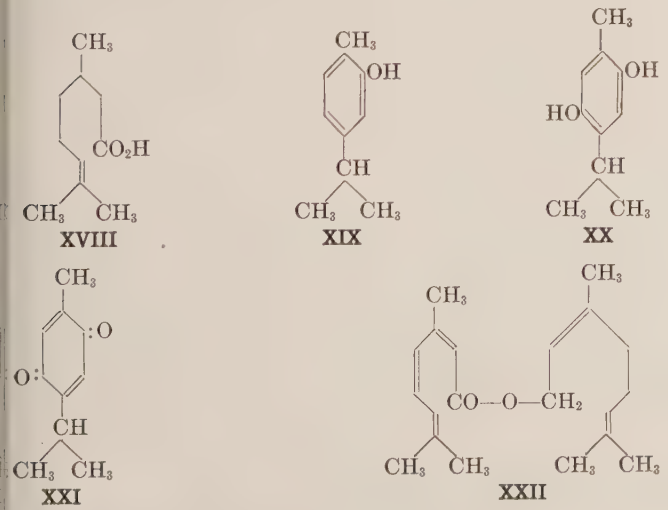
The Australian *Callitris glauca, C. intratropica* and, probably, also other *Callitris* species contain, apart from the sesquiterpene alcohol guaiol (**XVII**) a compound called callitrol which for a long time was considered to be a phenol. Later, however, callitrol was shown to be *l*-citronellic acid (**XVIII**).

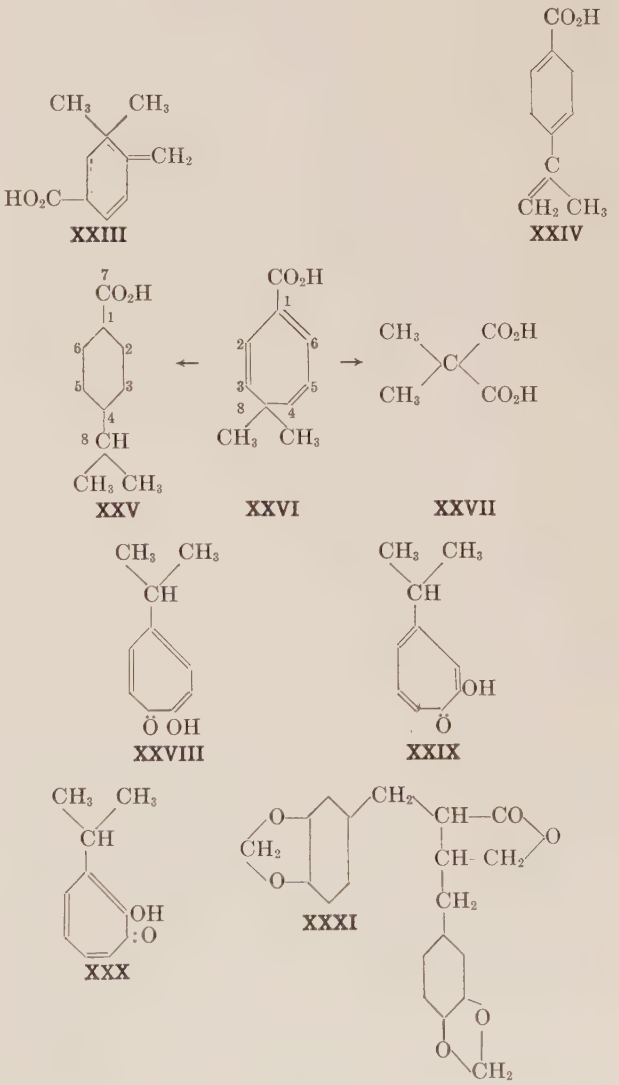
Because of the presence of this acid and of guaiol, the wood is not attacked by white ants. Guaiol is a strong insecticide and callitrol is a fungicide.

From the wood of the African *Callitris quadrivalvis,* carvacrol (**XIX**), its oxidation product hydrothymoquinone (**XX**), and the dehydrogenation product of the latter, thymoquinone (**XXI**), have been obtained. Carvacrol is a strongly fungicidal compound. Hydrothymoquinone is not very active. Hydrothymoquinone is easily dehydrogenated to thymoquinone and it is doubtful whether or not the wood originally contains the quinone, which is a very strongly fungicidal compound. It appears more probable that thymoquinone is formed from the hydroquinone—e.g., when the wood is wounded. Thus one might look upon hydrothymoquinone as being a potential fungicide which is mobilized when the wood is wounded. The wood of *Callitropsis araucarioides* (New Caledonia) contains dehydrogeranic acid, a compound closely related to "callitrol," in the form of its geranyl ester (**XXII**). Dehydrogeranic acid is a weak fungicide.

The Japanese Hiba, *Thujopsis dolabrata,* contains an acid identical with or closely related to "callitrol" which is very toxic to *Fomes annosus.*

From the heartwood of *Libocedrus formosana,* which is resistant to white ants, a series of steam-volatile acids (melting at 40–41°, 78–81°, and 103°) has been isolated. The former acid has been called shonanic acid and has the composition $C_{10}H_{14}O_2$. The acid melting at 103° has the same composition. As the result of his investigations Ishikawa arrived at the formula (**XXIII**) for shonanic acid. This is a very novel structure which leads over to the series of strange compounds from the heartwood of *Thuja plicata* (western red cedar), which has been very recently elucidated in collaboration with J. Gripenberg.

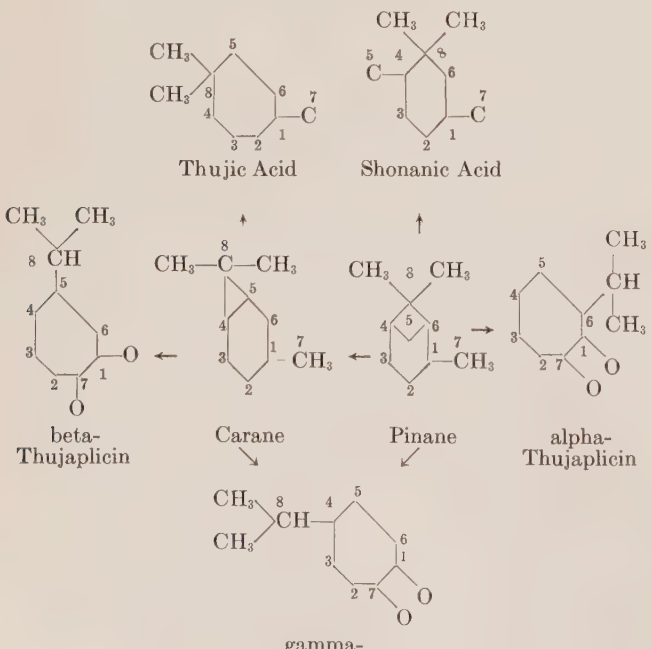




Earlier investigations, especially by A. B. Anderson, showed that the heartwood of this tree, which is very resistant to fungi and insects, contains an acid $C_{10}H_{12}O_2$ which was termed "dehydroperillic acid." This acid is almost nontoxic and rearranges easily when treated with acids to cuminic acid (**XXV**). Because of this and of the results of ozonization experiments, the formula (**XXIV**) was advanced for "dehydroperillic acid." The hexahydro derivative was supposed to be identical with one of the hexahydrocuminic acids. This, however, has been disproved. Further, "dehydroperillic acid" could be oxidized to dimethylmalonic acid (**XXVII**). Thus, it could be related to shonanic acid. Chromic acid oxidation of the acid itself and its hexahydro derivative, however, yielded almost the same amount of acetic acid. If "dehydroperillic acid" possesses a structure similar to that assumed for shonanic acid, one would expect the hexahydro derivative to yield more acetic acid than the original acid. At present **XXVI** appears to be the most probable structure of this acid. This structure would easily explain the facile isomerization to cuminic acid.

The name dehydroperillic acid was given to the compound because of the relation of the assumed structure to that of perillic acid. This name is misleading and should be abandoned in favor of *thujic acid.*

A toxic principle of the same empirical composition has been isolated from the very durable heartwood of *Thuja plicata* (western red cedar) shavings of which are used as an insect repellent. It possesses phenolic properties but it was found to be a representative of a new class of compounds possessing seven-membered rings (**XXVIII**). It is related to the mould metabolite stipitatic acid and to the alkaloid colchicine. It has been termed gamma-thujaplicin. The steam distillate of Swedish grown *Thuja plicata* contained a toxic isomeride possessing structure **XXX** (alpha-thujaplicin). One of Dr. Anderson's fractions from American grown *Thuja plicata* long remained liquid but slowly crystallized. The crystals were examined and this material, surprisingly enough, turned out to be still another highly toxic isomeride termed beta-thujaplicin (**XXIX**). Thus, *Thuja plicata* forms four different compounds, all having the empirical composition $C_{10}H_{12}O_2$ and all containing novel seven-membered ring structures. The thujaplicins yield chloroform-soluble metal complexes. Such complexes are probably the cause of the black stain developed when the wood is in contact with unprotected iron. The metal corrodes. Genetically, the thujaplicins and thujic acid are probably related to the terpenes especially of the carane and pinane types:



The heartwood of *Chamaecyparis obtusa* (the Japanese hinoki) is very durable. From the extracts, a lignan hinokinin (**XXXI**) has been isolated. This is of great interest because it shows that some of the *Cupressaceae* are able to produce compounds of the types previously found only in the *Pinaceae.* A liquid compound (or mixture of compounds), hinokitin, which is an isomer of the thujaplicins and which also yields metal complexes, has been isolated from the same source, together with a phenol and a ketone (hinokiol viz. hinokione) which obviously belong to the diterpene group. Hinokitiol has been claimed to contain a seven-membered ring. The structure, however, is not elucidated and one may suspect that hinokitiol may turn out to be a mixture of thujaplicins, preferentially alpha- and beta-thujaplicin. Mixtures of these compounds are not separated very easily and do not crystallize readily.

Much work remains to be carried out on the heartwood constituents of the *Cupressaceae,* especially the genera *Cupressus* and *Biota* (Chinese arbor vitae) and the results will undoubtedly be of great taxonomic interest.

The junipers, also belonging to the *Cupressaceae,* generally possess very durable heartwoods. They contain cedrol (**XVI**) which is a sesquiterpene alcohol like guaiol (**XVII**). It is not known whether these alcohols are fungicidal but this appears probable, in view of their close structural relationships and the fact that guaiol is an insecticide. This question is being investigated.

Taxus and *Torreya* were formerly considered to be conifers. Very little is known about the constituents of their very durable heartwoods. They probably contain fungicidal components. From a chemical point of view, the fact is interesting that the leaves of *Taxus baccata,* the common yew, contain ephedrin (J. M. Gulland), an alkaloid from several *Ephedra* species (family *Gnetaceae,* natural order *Gnetales,* like the yews and conifers belonging to the gymnosperms).

Only a small number of the conifers have been chemically investigated, especially with regard to their heartwood constituents. Already, however, many interesting interrelationships are known and more will become available through further studies. It would be possible to include terpenes and resin acids in a comparative study like this. Many observations of great taxonomic interest have been made in this special field, but a survey of these compounds is entirely outside the scope of this paper.

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The Ultraviolet Absorption Spectra of Complex Hydroxy-Aromatic Compounds and Derivatives, with Particular Reference to Lignin

EDWARD J. JONES, JR.

A review is given of the ultraviolet absorption spectra of lignin and of pure compounds which might be considered as progenitors of lignin.

Since the development, around 1930, of relatively simple and accurate methods of quantitatively determining the ultraviolet absorption spectra of organic compounds in solution, extensive use of this tool has been made as a supplement to chemical methods in determining structural features of natural and synthetic compounds. Many important contributions have been made particularly with respect to distinguishing between isomeric forms or possible spatial arrangements where the choice lay between a chromophoric resonating structure and a nonabsorbing form.

The ultraviolet spectrographic method has been applied extensively in the field of natural plant materials. For the purpose of this discussion, a large class of these compounds might be designated as hydroxy-aromatic compounds and derivatives in that, regardless of the complexity of their structure, they possess in common oxygen-substituted benzene rings, the oxygen being part of a hydroxyl, ether, or ester grouping. Such a broad classification would include such diverse materials as the flavylium coloring matters and flavanones, the tannins, the lignans, and lignin preparations. All these materials have been subjected to ultraviolet spectrographic studies and, in the case of the lignans, where a large group of compounds of known structure belonging to this family was available, it has been possible to relate variations in ultraviolet spectra to structural type (*1*).

Lignin, in particular, has received much attention, both because of its volume importance and because chemical methods have thus far failed to establish the details of its structure. During the past twenty years, four major studies of the ultraviolet spectrum of lignin have been published. Herzog and Hillmer (*2–8*), in a series of seven papers, collected the spectra of lignins from a number of sources and systematically assembled comparable data for some 80 or 90 simple aromatic compounds. Glading (*9*) studied the spectrum of spruce native lignin and a number of its derivatives as related to a group of model aromatic compounds. Patterson and Hibbert (*10, 11*) determined the spectra of a number of phenylpropane derivatives and compared these with the spectra of softwood (spruce) and hardwood (maple) lignins. Aulin-Erdtman (*12*) compared the spectra of lignosulphonic acids and spruce native lignin with a comprehensive group of synthetic model compounds.

In analyzing their experimental results, all these authors have agreed in concluding that the ultraviolet spectrum of lignin is that of a substituted benzene nucleus, yet each, in attempting to completely account for the shape of the curve, has given a different interpretation. Herzog and Hillmer reached the conclusion that the spectrum of lignin definitely showed the material to be made up of partly or completely methylated catechol or pyrogallol nuclei joined together with a side chain of about three carbons, the side chain containing no ethylenic double bonds or carbonyl groups in conjugation with the benzene ring (*7, 8*). They also cautiously pointed out that polymerized coniferyl alcohol gives an absorption spectrum almost identical with those of alkali lignin and lignosulphonic acids from a number of sources and suggested that this might indicate close structural similarity (*6*). Glading definitely concluded that the spruce native lignin spectrum demonstrated the presence of oxygen rings of the flavan or flavanone type in the lignin structure, and assigned the characteristic lignin band at 280 mμ to this unit. He also suggested that the shape of the lignin curve in the 350 mμ region may be the result of a "hidden" carbonyl band centered at 352mμ. Patterson and Hibbert concluded that the spectra of amorphous lignins can be explained satisfactorily on the assumption that they are derived from lignin precursors, such as 1-(4-hydroxy-3-methoxyphenyl)-1-propanone and 1-(4-hydroxy-3,5-dimethoxyphenyl)-1-propanone. They assigned the masked 310 mμ band to a carbonyl group in conjugation with the aromatic nucleus, the 280mμ band to "meta position freedom," and the indicated 220 to 230 mμ band to some unexplained characteristic of the benzene nucleus. Aulin-Erdtman concluded that the lignin spectrum in the 220 to 280 mμ region supported the Freudenberg furan or pyran ring structure for lignin, but noted that some additional chromophoric structure, such as a conjugated double bond system, would be required to account for the absorption curve at longer wave lengths.

This conflict in interpretation of the lignin spectrum, together with the growing list of materials that

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have practically identical spectra as lignin, has produced two very undesirable effects. On the one hand, the conclusions of these workers are being used in support or in lieu of chemical data by other workers in the field in arriving at even more conflicting conclusions. On the other hand, the apparent confusion is creating among many a distrust of the method itself.

It would appear that, with the great amount of experimental data collected in the four basic investigations, it should now be possible to analyze the over-all picture and formulate an interpretation of the lignin spectrum that would satisfy all the experimental facts. A review of the work was made with this in mind, and an analysis drawn which seems to satisfy the requirements. To justify the conclusions reached, it is first necessary to review briefly some fundamental principles of ultraviolet absorption spectroscopy.

The source of spectral absorption bands is discussed in many texts and review papers (*13, 14*). It is important to emphasize the following points in the present discussion.

Strong molecular absorption in the ultraviolet is usually associated with structures capable of resonance between several configurations, such as a system of conjugated double bonds. The benzene nucleus is such a system, although its absorption becomes large only in the high-frequency ultraviolet range (200 to 220 mμ.) Substitution in the molecule may have the effect of increasing the number of possible resonant configurations, resulting in greater absorption at lower frequency. Substitution of —OH, —SH, or —NH_2 groups into the benzene nucleus, for example, is known to have this effect. A few chemical groups, such as C=O, —NO_3, —N=N—, are more or less self-contained resonating systems and, if isolated from strong intermolecular influences such as conjugation, will produce characteristic absorption bands in the ultraviolet. The over-all absorption spectrum of a complex compound of unknown structure should be thought of as the integrated resultant of a number of overlapping bands. Some of these bands may be strong enough so that their maxima stand out distinctly, others may be relatively weak and hidden. The location and intensity of the maxima are the most specific data that can be obtained from the curve. The apparent broadness of consecutive bands, as reflected in the location of the minimum between them, is such a complex function that only the broadest generalizations can be drawn from their position. The over-all curve itself is a unique property of a particular compound, but the degree of differentiation within a family falls off rapidly as the complexity of the members increases, particularly when the individual variations involve inactive groups and linkages.

With these principles in mind, we can now turn to the question of the significance of the lignin spectrum. For a starting point, it is necessary to accept some basic chemical evidence regarding the structure of the material. For this purpose, it is taken as established that lignin has some type of aromatic structure and contains no large proportion of unsaturated aliphatic units. This is necessary since it is undoubtedly true that a complex or mixture of unsaturated aliphatic compounds could be found that would give an ultraviolet spectrum indistinguishable from that of lignin, and the task of classifying all such possible compounds on a purely spectrographic basis would be hopeless.

Accepting the stated chemical premise, an examination of the absorption curves of aromatic compounds in the papers being considered and in such a collection as that given in International Critical Tables (*15*) at once brings out the following facts:*

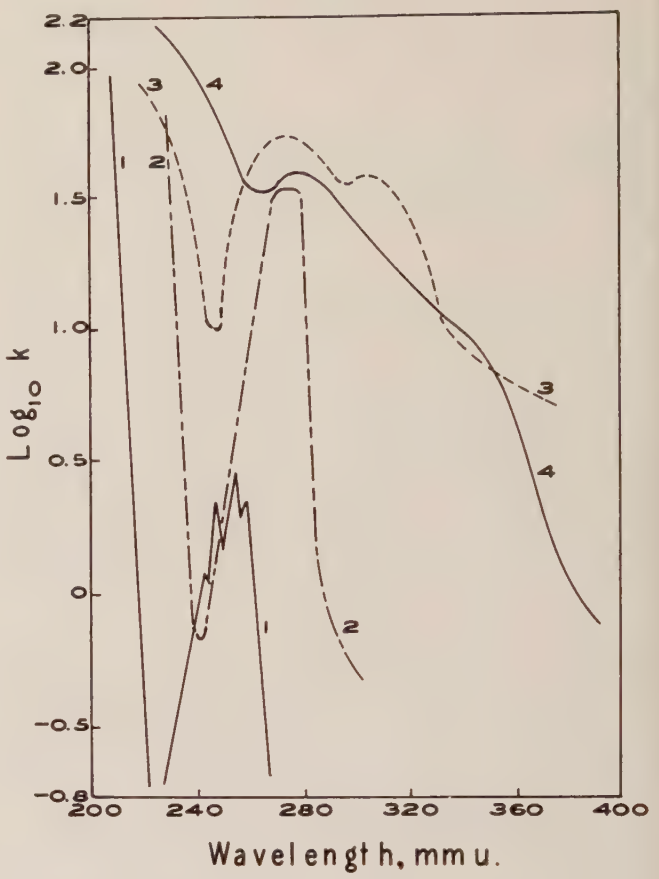


Fig. 1

Curve 1, benzene in hexane (*7*); curve 2, phenol in alcohol (*9*); curve 3, 2-hydroxy-1-(3,4-dimethoxyphenyl)-1-propanone in alcohol (*10*); curve 4, spruce native lignin in 90% dioxane (*9*).

A. Benzene itself has two bands, one very strong at 200mμ, a second of about one-thirtieth the intensity at 255 mμ (Table 1 and Fig. 1). The absorption curve drops sharply to near transparency beyond this wavelength.

B. Substitution of saturated carbon chains, as in toluene, the xylenes, and *n*-propylbenzene, causes a shift of both maxima toward the red and a slight intensification. Para disubstitution has the greatest effect (*p*-xylene, Table I).

C. Unsaturation in positions other than alpha to the ring (nonconjugated) has little effect on the ultraviolet spectrum (γ-phenylpropylene, Table I).

* The ultraviolet curves of some of the materials considered were determined in nonpolar solvents such as hexane, others in polar solvents such as alcohol. By ignoring the fine structure sometimes shown in the nonpolar solvents, the values are comparable within the desired limits.

D. The substitution of oxygen on the benzene ring has a pronounced effect on the position and intensity of the two maxima (phenol, Table I and Fig. 1). These values are relatively unchanged for catechol, resorcinol, methylated phenols, methylene-ether linkages, or ether-linked side rings. Again, para disubstitution has the most pronounced effect (hydroquinone, Table I). The only effect of catechol disubstitution appears to be a broadening of the bands, resulting in a more shallow minimum that is shifted toward the red (*7*). In the case of the trisubstitution of pyrogallol and its derivatives, however, there is, in addition to a further shift and rise of the minimum, a suppression of the oxygen auxochrome effect in the long wavelength band (pyrogallol, Table I).

It should be borne in mind that the increase in absorption through oxygen substitution is restricted to the two bands described. In all the compounds considered, the sharp drop in the absorption curve following the second longer wavelength maximum is characteristic.

Table I

Substance	*Maximum A* $m\mu$ $\log_{10} \epsilon$[a]		*Maximum B* $m\mu$ $\log_{10} \epsilon$		*Maximum C* $m\mu$ $\log_{10} \epsilon$		*Reference*
Benzene	200	3.8	255	2.3	...	..	(*7*)
p-Xylene	212	3.9	263	2.8	...	..	(*15*)
γ-Phenylpropylene	Not reached		261	2.3	...	..	(*5*)
Phenol	215	3.9	275	3.4	...	..	(*7*)
Hydroquinone	225	3.6	295	3.4	...	..	(*15*)
Pyrogallol	Not reached		265	2.9	...	..	(*7*)
α,α'-Phenylpropylene	Not reached		260	3.3	286	2.7	(*5*)
Propiophenone	242	4.0	280	2.9	316[b]	1.6	(*16*)
α-Indanone	242	4.1	291	3.6	...	..	(*16*)
Hydrocinnamaldehyde	252	2.6	269	2.6	302	1.7	(*5*)
β-Indanone	Not reached		268	2.8	278	3.0	(*16*)
p-Isoallylphenol	Not reached		260	4.3	292	3.4	(*5*)
Isoeugenol	Not reached		262	4.2	292	3.7	(*5*)
2-Ethoxy-1-(4-hydroxy-3-methoxyphenyl)-1-propanone	230	4.2	283	4.0	306	3.9	(*10*)
2-Hydroxy-1-(3,4-dimethoxyphenyl)-1-propanone	229	4.2	274	4.1	311[b]	3.7	(*10*)

[a] ϵ = Molecular absorption coefficient in: $T = e^{-\epsilon cl}$
T = transmittance of solution (as compared with solvent)
e = base of natural logarithms
c = concentration of solute in moles per liter
l = thickness of solution through which light passed, in cm.

For comparison with Fig. 1, $\epsilon = k \times$ molecular weight, where k is the absorption coefficient when the concentration is expressed in grams per liter.

[b] Inflection point.

E. Finally, there is another class of chromophoric groups that must be taken into consideration. A double bond in the alpha-beta position of a side chain or a carbonyl group in the alpha position has an effect comparable with oxygen substitution on the benzene bands. However, a unique effect of the conjugated unsaturated groupings is that a third band at longer wavelength is always introduced (α,α'-phenylpropylene and propiophenone, Table I). Conversion of this side chain to a cyclonone appears to merge and intensify the long wavelength bands (α-indanone, Table I).

Although, as has been pointed out, nonconjugated double bonds in the side chain do not appreciably affect the benzenoid ultraviolet spectra, a carbonyl group in removed positions still produces an appreciable, though reduced, effect (hydrocinnamaldehyde and β-indanone, Table I).

When the alpha-beta double bond or carbonyl group is combined with a phenoxy nucleus, the two bands common to both groups are of such intensity that the third band associated with the unsaturated linkage may appear or may be "hidden" as an inflection in the curve or high general absorption in that region (*p*-isoallylphenol, isoeugenol, 2-ethoxy-1-(4-hydroxy-3-methoxyphenyl)-1-propanone, and 2-hydroxy-1-(3,4-dimethoxyphenyl)-1-propanone, Table I and Fig. 1).

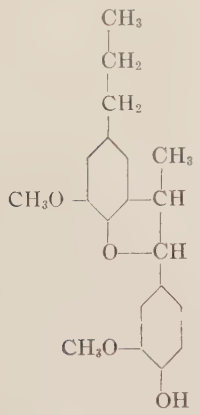
In order to illustrate further the relative course of the absorption curve of the compound discussed to that of lignin, a selected group has been plotted in Fig. 1. Since the spectrographic absorbing unit of lignin is not known, the plot is on the basis of weight concentration rather than mole concentration. It is interesting in this connection, and possibly significant in relation to the interpretation to follow, that Aulin-Erdtman was able to demonstrate that, by reducing absorption data for a number of lignosulphonic acids of widely varying methoxyl content to absorption per unit methoxyl content, the resulting absorption curves fell very close together.

With these facts assembled, the experimental data in the four works on the lignin spectrum cited can now be re-examined.

Herzog and Hillmer quite clearly demonstrated the relationship of the spectrum of lignin to simple phenoxy compounds. There is no apparent justification from spectrographic evidence with such a high molecular weight material of unknown composition for their specific conclusion that the spectrum is definitely of the catechol or pyrogallol type. Herzog and Hillmer's conclusion that the lignin spectrum definitely proved the absence of double bonds or carbonyl groups in conjugation with the benzene ring was apparently based on an assumption that lignin must be a polymer of chemically identical building stones. If such were true, their conclusion would probably be justified. Since later chemical studies make it at least equally possible that there may be considerable variation among the building stones of the lignin polymer, there is no basis for ruling out a small proportion of unsaturated conjugation. Their observation that polymerized coniferyl alcohol gave a very similar absorption spectrum is simply another example in the long list that now exists of chemically different compounds that belong to this spectrographic class.

Glading's conclusion that the 280 $m\mu$ band in the lignin spectrum is specifically ascribable to the furan or pyran side ring of the Freudenberg formula is definitely incompatible with the well-established lack of ultraviolet activity of saturated groupings. The lack of influence of such a side chain has been most clearly demonstrated by Aulin-Erdtman, although the conclusion was not stated by the author, when she showed the spectra of dihydrodehydrodiisoeugenol (**I**) and

α-(3,4-dimethoxyphenyl)-β-(3-propyl-5,6-dimethoxyphenyl)propane (**II**) to be nearly identical. Glading



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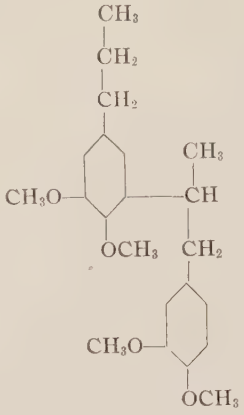
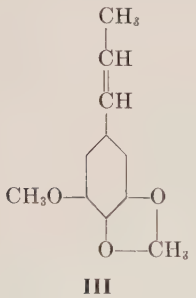


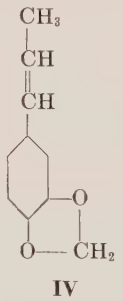
II

was the first to point out that more than the phenoxy nucleus and saturated substituents is required to account for the high absorption and implied maximum in the 300 to 350 mμ region of the lignin spectrum. His suggestion that this may be the result of a carbonyl group is entirely consistent with the facts reviewed, but must not be taken as anything more than a hypothesis until a great deal more chemical and spectrographic work has been done.

The phenylpropanone model compounds studied by Patterson and Hibbert all belong to the spectrographic class discussed under Section E—that is, they contain the strong mixed chromophoric phenoxy and carbonyl groups which may produce either three strong ultraviolet bands or, through merger, show only two maxima. The assignment of the 295 to 320 mμ band in these compounds to the carbonyl group and the 220 to 230 mμ band to the benzene nucleus is in accord with the present general consideration. However, the assignment of the 280 mμ band to "meta position freedom," although possibly acceptable in this narrow group of compounds in a negative sense, is definitely misleading when applied generally and used for interpreting the spectrum of lignin. For example, isomyristicin (**III**) and isosafrole (**IV**) show equally strong maxima in this range, but the 310 mμ maximum of the conjugated double bond is absent in the former compound (Table I). It would appear that consideration of a restricted group of compounds of this class might lead to the erroneous conclusion that the 310



III



IV

mμ band should be assigned to "meta position freedom." It seems much more correct to say that under certain structural conditions, tri-oxi substitution being one (Section D), the 260 to 280 mμ and 295 to 320 mμ bands characteristic of conjugated unsaturation substitution on the phenoxy nucleus may become fused with a single strong maximum appearing in the range 270 to 300 mμ. The suppressing effect on the 275 to 280 mμ phenoxy band of tri-oxi substitution is evident in comparing the curves given by these authors for spruce and maple lignins. Their conclusion that the nature of the lignin curve in the 300 to 350 mμ region "suggests that a carbonyl group or ethylenic double bond in conjugation with the benzene ring is present *to some extent*," agrees with the findings of Glading but still has no experimental proof.

Aulin-Erdtman's conclusion that the ultraviolet absorption spectra of the model substances studied offer evidence supporting Freudenberg's furan or pyran ring structure for lignin is voided by the same facts discussed in connection with Glading's argument on this point.

To sum up, an evaluation of the experimental evidence regarding the ultraviolet absorption spectrum of lignin leads to the following conclusions.

1. The two characteristic bands in the lignin spectrum at 200 to 230 mμ and 275 to 285 mμ are specifically attributable to the oxygen-substituted benzene nucleus in lignin.
2. The high absorption in the 300 to 350 mμ range suggests the presence of a "masked maximum" and indicates the presence of other chromophoric groups in lignin—for example, carbonyl groups or double bonds conjugated with the benzene ring.

Attempts to further extend the interpretation of the lignin spectrum on the basis of slight shifts in position or intensity of the maxima or changes in position of the minimum point appear entirely unjustified at the present stage of knowledge of the lignin structure. Such speculative interpretations have the harmful effect of growing to the status of proved experimental evidence and being misused in good faith by other workers in the field as unquestionable evidence in support of some currently popular hypothesis. To make this point clear, a few examples should be cited.

Early in the development of the application of ultraviolet absorption methods to lignin materials, several papers appeared in which lignin was definitely claimed to be synthesized from cellulose by simple heat treatment (*17, 18, 19*). This claim rested almost entirely on the fact that the ultraviolet absorption curve of the product showed the 275 to 285 mμ maximum and the general shape of the lignin curve, in spite of the fact that the intensity of absorption at the maximum point of the unknown material was less than that of spruce lignosulphonic acid by a factor of six (*19*). Little effort has since been made to defend the thesis that such material is in any sense lignin, but the work is still cited to discredit *any* use of ultraviolet spectrochemistry in the lignin field. The true nature of the heated cellulose product and the source of its ultraviolet absorption curve could probably be fairly easily determined on the basis of a series of papers recently published dealing with the acid hydrolysis of simple hexose sugars (*20, 21, 22*). The hydroxymethylfurfural which is produced has the characteristic 280 mμ carbonyl absorption band, and it may be seen in the figures given that,

under certain conditions, the absorption curve of a hydrolyzed sugar mixture is very similar to that of lignin.

Such use of the lignin absorption curve has not died out. Ritter and co-workers (*23*) have interpreted Patterson and Hibbert's work as identifying the 280 mμ peak with the carbonyl group and used this to support their polyflavanone formula for lignin. The demonstration by Aulin-Erdtman of the nearly identical ultraviolet curves from **I** and **II** was an experiment designed to check Freudenberg's theory that a side ring is opened in the sulphonation of lignin. The negative result of this experiment has apparently been interpreted by H. Erdtman (*24*) as disproving Freuenberg's theory. The fact that the experiment actually proves that the ultraviolet spectrum offers no evidence concerning the presence or absence of a saturated side chain has already been shown.

Finally, it is desired to state an important conclusion arising from the two points established in regard to the lignin spectra—e.g., the assignment of the maxima to the oxygen-substituted benzene nucleus and the indicated presence of other chromophoric groups. It has been shown that the oxygen substitution on the benzene ring is responsible for at least a tenfold increase in absorption resulting in the 280 mμ maximum and that this maximum overlaps a possible band in this region associated with conjugated unsaturation. It is suggested, therefore, that, if some method were available for replacing the phenolic hydroxyl and methoxyl groups in lignin with alkyl groups or hydrogen atoms, the ultraviolet spectrum of the product would be much more illuminating in regard to other chromophoric groupings and spectrographic comparison with analogous model compounds might be much more fruitful.

The basis for the generalization of the title of this paper to "complex hydroxy-aromatic compounds and derivatives" lies in the fact that a number of groups of such compounds, known to vary widely in chemical composition but possessing the oxygen-substituted benzene nucleus in common, have been shown to have ultraviolet absorption curves very similar to that of lignin—all showing the 220 to 230 mμ and 270 to 285 mμ maxima. These include the flavylium and flavone compounds (*25*), the lignans (*1*), and the natural tannins (*26*).

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Comparison of Several Freeness Testers on Board Stock

Williams Freeness Values

C. E. HRUBESKY

In cooperation with the Raw Materials Testing Sub-committee of the TAPPI Structural Fibrous Materials Committee, Williams freeness tests were made at the U. S. Forest Products Laboratory on 15 structural board stocks to compare with values previously obtained with five different freeness testers. Although no exact correlation was found to exist between the freeness values obtained with the Williams and the other testers, the spread in values for different stocks obtained by using a relatively high consistency is approximately of the same order as values obtained with the Schopper-Riegler oversize tester, which showed a greater spread than the other testers used.

At the February, 1948, meeting of the Technical Association of the Pulp and Paper Industry, results of freeness tests made at the Forest Products Laboratory with several freeness testers on board stock were reported (*2*). The tests were run on free, normal, and slow stock from each of seven board manufacturers to compare a Schopper-Reigler (regular), Schopper-Riegler (modified), Canadian Stand-

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ard, Oliver, and Fir-Tex tester. Tests with a Williams tester were started but were not completed in time to be included in the report given at that time.

The purpose of this paper is to describe some results obtained at the Forest Products Laboratory with the Williams Precision Model Freeness Tester on pulps under various conditions of temperature and quantities of pulp used.

RAW MATERIALS

The stocks used in this study consisted of the same free, normal, and slow stocks used for the tests described in the previous report except for several of the stocks which were depleted in making the former tests. These were stocks submitted at the request of the chairman of the Raw Materials Testing Sub-committee, Structural Fibrous Materials Committee, Technical Association of the Pulp and Paper Industry, by each of seven manufacturers of insulating board.

EQUIPMENT

The tester used was a Williams Precision Model which measures freeness by the time in seconds required for 1000 ml. or a smaller quantity of water to drain through a strainer from a definite suspension of pulp at atmospheric pressure.

The Williams tester is normally used with 3 grams of oven-dry pulp in a volume of 1000 ml. (equivalent to 0.35 gram per square inch of screen area) at a temperature of 77°F. (25°C.). The strainer is a 62-by 80-mesh wire screen having an area of 8.6 square

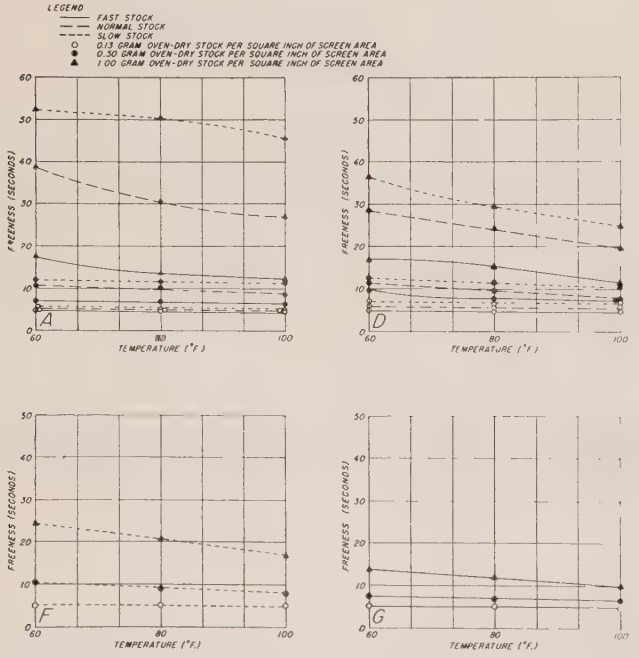

Fig. 1. Effect of temperature and quantity of stock on freeness values of stocks A, D, F, and G

inches. The free-water value for 1000 ml. at 80°F. is 4.8 seconds.

EXPERIMENTAL

Weighed samples of the pulps were disintegrated in water of the desired temperature by means of the standard disintegrator described in TAPPI Method T 205 m. Tests were run in duplicate.

The results of the tests are shown in Table I.

In addition to the values obtained for drainage of 1000 ml. of water, the times required for drainage of 700 and 300 ml. of water were obtained for several pulps.

Effect of Weight of Stock on Freeness Values

As shown in Figs. 1, 2, and 3, an increase in the

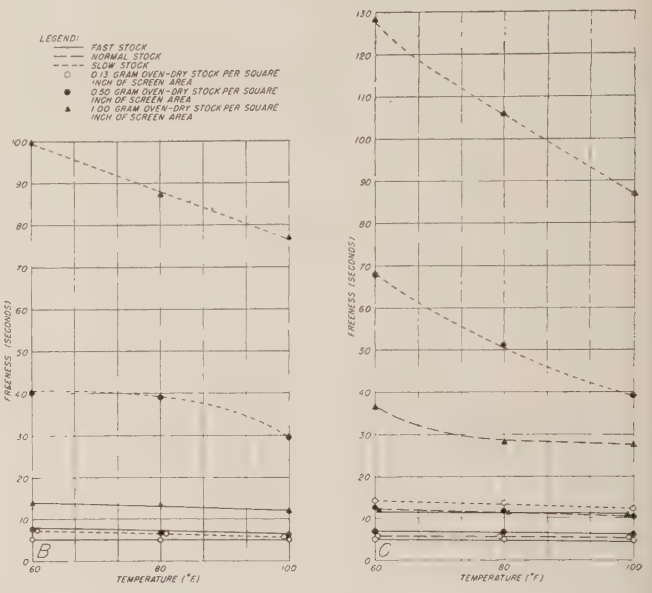

Fig. 2. Effect of temperature and quantity of stock on freeness values of stocks B and C

weight of stock from 0.13 to 1.0 gram per square inch of screen area had a marked effect in reducing the apparent freeness values of stocks B, C, and E and a lesser effect on the other stocks. As expected, the effect is greatest with slow stocks and least with free stocks.

Effect of Temperature on Freeness Values

Figures 1, 2, and 3 show that an increase in temperature from 60 to 100°F. considerably increases the drainage rate of slow stocks used at a consistence of 0.86% (1 gram of stock per square inch of screen area). As the consistence is decreased, the effect of temperature decreases, so that at consistencies below 0.43% (0.5 gram of stock per square inch of screen area) temperature has little effect. The effect of temperature on the drainage rate of the free stocks is not great even at a consistency of 0.86%.

Rate of Drainage for Different Volumes of Water

In order to obtain drainage-rate curves, the time required for 300, 700, and 1000 ml. of water to drain through several stocks was determined. These curves, shown in Fig. 4, indicate that the relative drainage rate of different pulps may vary as pulp collects on the screen. For example, the curves for the normal A and E stocks show a higher freeness than the slow D stock for drainage of 700 ml. of water, but show a lower freeness for drainage of 1000 ml. of water.

It has been pointed out by Williams (*1*) and Bachman (*3*) that the freeness characteristics of a stock

Table I. Effect of Temperature and Weight of Stock on the Williams Freeness Values of Board Stocks

Stock	Temperature, °F.	Free stock: Freeness for 1000 ml. Gram moisture-free stock per sq. in. screen area 0.13 Sec.	0.50 Sec.	1.0 Sec.	Freeness for 700 ml. Gram moisture-free stock per sq. in. screen area 0.13 Sec.	0.50 Sec.	1.0 Sec.	Freeness for 800 ml. Gram moisture-free stock per sq. in. screen area 0.13 Sec.	0.50 Sec.	1.0 Sec.	Normal stock: Freeness for 1000 ml. Gram moisture-free stock per sq. in. screen area 0.13 Sec.	0.50 Sec.	1.0 Sec.	Freeness for 700 ml. Gram moisture-free stock per sq. in. screen area 0.13 Sec.	0.50 Sec.	1.0 Sec.	Freeness for 800 ml. Gram moisture-free stock per sq. in. screen area 0.13 Sec.	0.50 Sec.	1.0 Sec.	Slow stock: Freeness for 1000 ml. Gram moisture-free stock per sq. in. screen area 0.13 Sec.	0.50 Sec.	1.0 Sec.	Freeness for 700 ml. Gram moisture-free stock per sq. in. screen area 0.13 Sec.	0.50 Sec.	1.0 Sec.	Freeness for 800 ml. Gram moisture-free stock per sq. in. screen area 0.13 Sec.	0.50 Sec.	1.0 Sec.
A	60	5.0	7.2	17.4	..	..	...	..	..	...	5.0	10.9	39.2	..	5.6	13.3	..	1.5	2.4	5.0	12.2	52.6	..	..	..	..	..	...	..	..	...
	80	4.9	7.0	13.9	..	..	...	..	..	...	5.0	10.1	31.2	..	5.3	10.0	..	1.4	1.7	5.0	11.6	50.7	..	..	..	..	..	...	..	..	...
	100	4.8	6.5	11.2	..	..	...	..	..	...	5.0	8.7	26.8	..	4.7	8.3	..	1.2	1.5	5.0	11.1	45.8	..	..	..	..	..	...	..	..	...
B	60	5.1	7.7	14.1	..	3.8	5.9	..	1.8	2.1	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	7.4	40.2	100.3	..	14.0	34.7	..	2.0	2.3	..	1.8	2.3
	80	5.0	6.9	13.3	..	3.5	5.4	..	1.7	2.0	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	6.4	39.1	87.4	..	12.3	32.0	..	1.8	2.3	..	1.8	2.3
	100	5.0	6.3	12.4	..	3.2	5.1	..	1.7	2.0	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	5.9	29.6	77.4	..	9.3	27.1	..	1.8	2.3	..	1.8	2.3
C	60	5.0	7.0	12.3	..	..	...	..	..	...	5.8	12.6	36.7	..	..	..	..	..	..	14.3	68.0	128.0	..	..	..	..	..	..	..	..	..	...
	80	4.9	6.8	11.4	..	..	...	..	..	...	5.5	11.9	28.6	..	..	..	..	..	..	13.7	51.1	106.0	..	..	..	..	..	..	..	..	..	...
	100	4.8	6.1	10.8	..	..	...	..	..	...	5.3	10.4	27.6	..	..	..	..	..	..	12.3	39.1	87.1	..	..	..	..	..	..	..	..	..	...
D	60	5.0	9.5	17.0	..	4.9	7.6	..	1.9	3.0	5.4	11.2	29.1	..	5.4	9.9	..	2.3	3.2	6.1	12.8	36.5	..	6.3	16.0	..	2.3	3.0	..	2.3	3.0
	80	4.9	7.8	15.8	..	4.0	6.3	..	1.7	2.3	5.1	9.7	24.3	..	4.2	8.7	..	1.8	3.0	5.1	11.9	29.3	..	5.2	14.0	..	2.3	3.0	..	2.3	3.0
	100	4.9	7.1	11.3	..	3.2	4.8	..	..	..	5.1	7.7	19.7	..	3.5	7.1	..	1.5	2.1	5.4	10.4	24.9	..	4.5	12.0	..	2.0	2.1	..	2.0	2.1
E	60	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	5.4	12.4	40.4	..	5.3	12.2	..	2.0	2.1	6.0	24.6	89.1	..	8.7	28.2	..	2.4	3.6	..	2.4	3.6
	80	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	5.2	11.8	37.0	..	4.8	10.1	..	1.7	1.8	5.6	22.7	75.0	..	7.3	25.0	..	2.1	3.0	..	2.1	3.0
	100	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	5.2	10.8	32.0	..	4.5	9.5	..	1.5	1.7	5.4	21.6	68.1	..	6.9	21.7	..	2.1	3.0	..	2.1	3.0
F	60	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	5.0	10.3	24.5	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
	80	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	5.0	9.0	20.9	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
	100	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	5.0	8.0	17.3	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
G	60	5.0	7.4	13.8	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)									
	80	5.0	7.0	12.2	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)									
	100	4.9	6.7	10.4	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)									

Note: (1) indicates insufficient stock.

at various points in the drainage of its water are more important than the end freeness for its control on a paper machine. No attempt was made in the work here reported to correlate freeness of a stock with its running properties on a machine.

Spread in Freeness Values

The spread in freeness values of board stock obtained with the Schopper-Riegler oversize tester, Schopper-Riegler regular tester, Canadian Standard tester, Oliver tester, and Fir-Tex tester (*2*) indicated that, under all conditions of test, the spread was

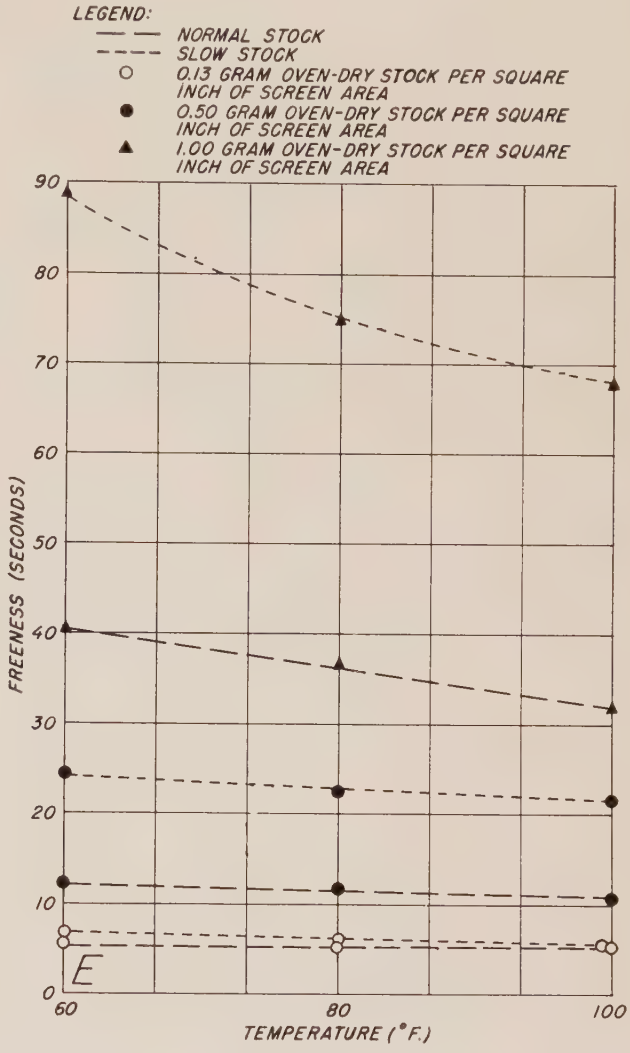

Fig. 3. Effect of temperature and quantity of stock on freeness values of stock E

with the others. Values obtained with this tester were taken as a standard to compare the spread in values obtained with other instruments. This comparison with the Williams freeness values is shown in Fig. 5, where the stocks are arranged in order of decreasing freeness as obtained with the Schopper-Riegler oversize tester.

Although the order of the stocks tested with regard to freeness values is different, the spread in values with the Williams tester was comparable to that with the Schopper-Riegler oversize tester.

When the stocks are arranged in order of increasing

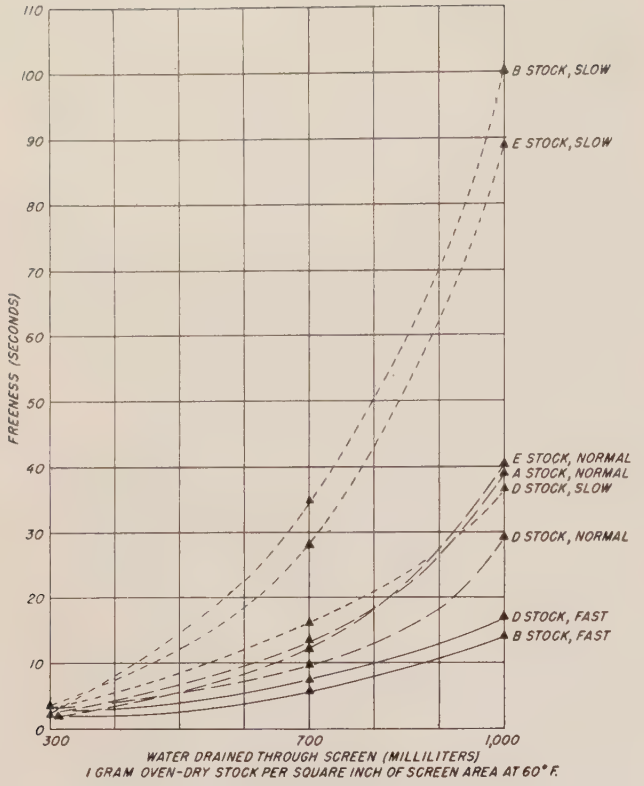

Fig. 4. Drainage time for varying quantities of water through different stocks

freeness values as obtained with the Williams instrument, the bar graph shown in Fig. 6 has about the same shape as that shown in Fig. 5 for values arranged in order of decreasing freeness as obtained with the Schopper-Riegler oversize tester, but, as seen in Fig. 5, the two testers do not rank stock in the same order.

CONCLUSIONS

On the basis of the tests made, it appears that no real correlation exists between the freeness values obtained with the Williams and a Schopper-Riegler oversize tester altered to take a 5-liter sample.

With board stocks used at about three times the normal consistency for tests with the Williams tester, the spread in freeness values for different stocks is approximately of the same order as values obtained with the altered Schopper-Riegler tester, but the ranking of the stocks is different.

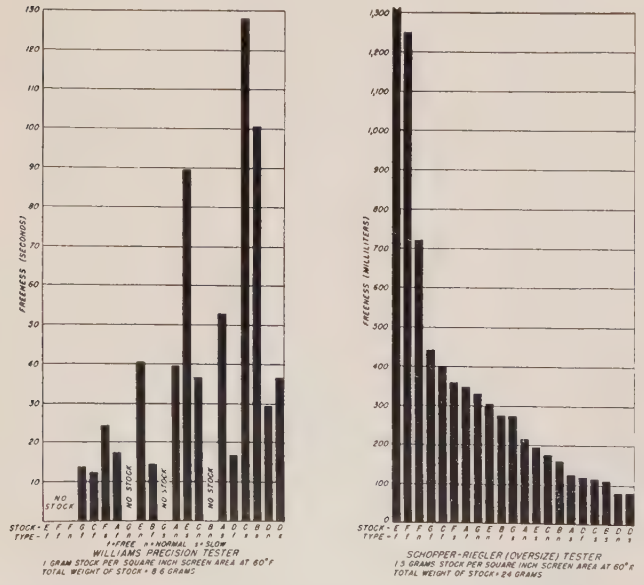
FREENESS (SECONDS)
NO STOCK
WILLIAMS PRECISION TESTER
1 GRAM STOCK PER SQUARE INCH SCREEN AREA AT 60° F.
TOTAL WEIGHT OF STOCK = 8.6 GRAMS
FREENESS (MILLILITERS)
SCHOPPER-RIEGLER (OVERSIZE) TESTER
1.5 GRAMS STOCK PER SQUARE INCH SCREEN AREA AT 60° F.
TOTAL WEIGHT OF STOCK = 24 GRAMS

Fig. 5. Comparison of freeness values obtained with the Williams tester and the Schopper-Riegler oversize tester. Stocks arranged in order of decreasing freeness as obtained with the Schopper-Riegler oversize tester

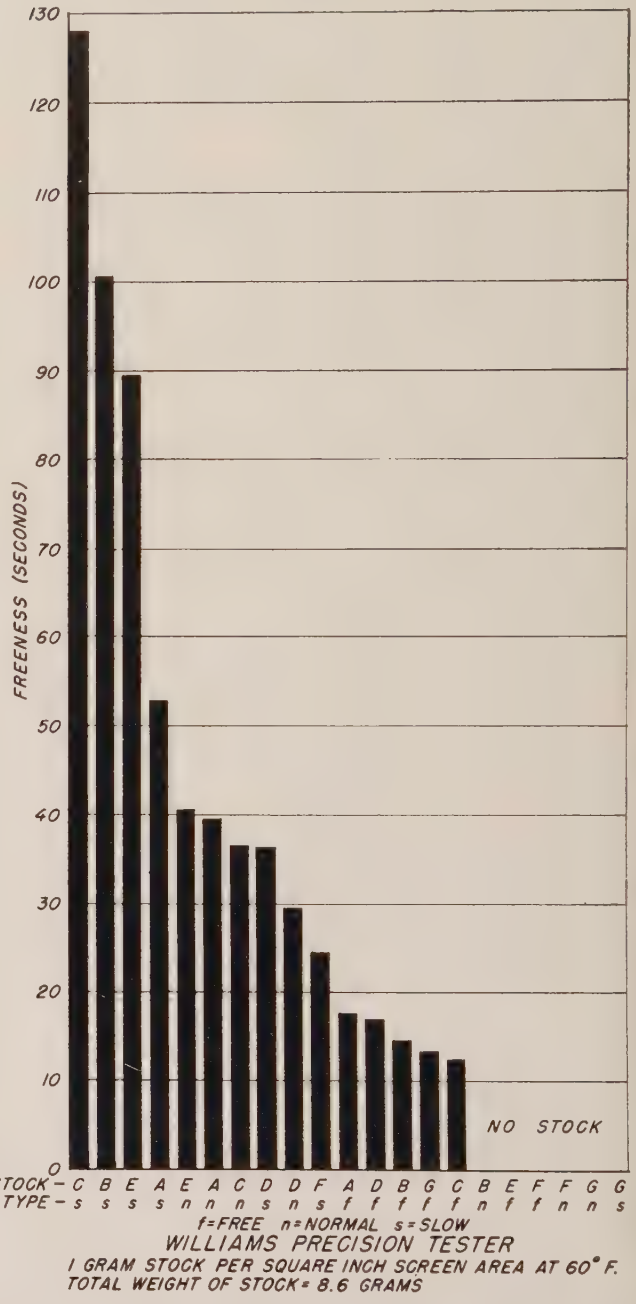
FREENESS (SECONDS)
NO STOCK
STOCK - C B E A E A C D D F A D B G C B E F F G G
TYPE - s s s s n n n s n s f f f f f n f f n n s
f = FREE n = NORMAL s = SLOW
WILLIAMS PRECISION TESTER
1 GRAM STOCK PER SQUARE INCH SCREEN AREA AT 60° F.
TOTAL WEIGHT OF STOCK = 8.6 GRAMS

Fig. 6. Spread in freeness values with the Williams tester. Stocks arranged in order of increasing freeness as obtained with the Williams tester

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Evaluation of Fibrous Agricultural Residues for Structural Building Board Products

III. *A Process for the Manufacture of High-Grade Products from Wheat Straw*

E. C. LATHROP and T. R. NAFFZIGER

The details of a process for the manufacture of high quality, very rugged insulating building board from wheat straw are presented. Two kinds of pulp are required: (1) unhydrated long fibered pulp, and (2) hydrated pulp equivalent to that used in strawboard manufacture. Two methods are described for the preparation of these: by pressure cooking or by a new very rapid method of atmospheric cooking and disk refining. The effect of operating variables on physical properties, such as straw varieties, cooking and refining, per cent hydrated fiber and per cent long fiber in pulp blends, per cent moisture of board into drier, have been carefully studied. Based on previous fundamental work it is possible to arrange this information in the form of an accurate operating range of pulp blends as related to properties of finished product. Due to the springy straw fibers the board may be dried at 50 to 55% moisture content with large savings in drying costs. Dense boards may be made by drying in the hydraulic press. Process equipment and economics are discussed.

Many inquiries during the past few years have been directed to the Northern Regional Research Laboratory concerning the manufacture of structural insulating building board products from agricultural residues. Sugarcane bagasse is a recognized raw material for the manufacture of such products not only in the continental United States but also in Hawaii, Australia, and England. Manufacture of bagasse products in several other countries has been under active consideration.

Although several hundred thousand tons of bagasse are still used annually for fuel by the sugar mills in the United States and projects for additional manufacture of board products from bagasse have been considered, several factors indicate the desirability of giving thought to the utilization of other agricultural residues for this purpose. Some of these factors are: (1) mills using bagasse must be located in the sugarcane-producing areas, confined to the Southern states, with high shipping costs to many parts of the country; (2) while at one time plants manufacturing in the South possessed the advantages of lower labor rates and low fuel and electric power costs, this advantage is now relatively less as compared with many locations in the great wheat-growing areas; (3) the cereal straws are produced in enormous tonnages in many widely separated areas, and this is particularly true of wheat straw; (4) there is a growing demand for more industrialization based on products of agriculture in these great agricultural areas with a consequent increase in population and a demand for housing; (5) the value of structural insulating board products in farm structures has become established and the demand for such products in agricultural areas will increase; (6) significant improvements have been made in the methods and costs of collecting and storing wheat straw; (7) based on fundamental studies of the relationship of fiber characteristics to the physical properties of board products the authors (*1, 2*) have concluded that wheat straw is an outstanding raw material for insulating building board manufacture.

This paper reports extended studies to develop a practical and economical process for the manufacture of a range of board products from straw.

FIBER PREPARATION, BOARD FORMATION, AND TESTING

In the second paper of this series, "Fundamental Studies on Wheat Straw Fiber" (*2*) the authors point out that two types of fibers are present in the furnish used for insulating board manufacture, whether the raw material is wood or agricultural fibers. These consist (1) of fiber bundles considerably longer than the ultimate papermaking fibers prepared from the specific raw material, and (2) of hydrated fibers. The long fiber component of wheat straw used in the study was prepared by passing straw from the bale through an ensilage cutter to reduce it to lengths of 0.5 to 1.5 inches. The chopped straw was cooked in water, with a 6:1 liquid-to-solids ratio on the basis of moisture-free straw for 1.25 hours at 142°C. (40 pounds steam pressure) in a 3-foot spherical digester. After the cooked straw was dumped from the digester it was allowed to drain and cool and was then refined through a 24-inch Bauer refiner, dressed with plates B1673 at a clearance between the plates of about 0.025 inch. The pulp from the refiner was passed through a rotary washer, the effluent from which was passed over a 100-mesh hillside screen. The pulp from the hillside screen was blended with the pulp from the washer. It was possible to duplicate closely the character of this pulp from run to run. For convenience this will be referred to as "unhydrated pulp."

The hydrated pulp was prepared by cooking unchopped wheat straw with 6% calcium oxide and 1.5% sodium hydroxide in a 7:1 liquid-to-solids ratio on the basis of moisture-free straw, for 5 hours at 142°C. (40 pounds steam pressure). The cooked straw was defibered in a 5-pound Noble and Wood beater

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equipped with a washer drum with the beater roll raised from the bed plate. After washing, the pulp was beaten with the roll lowered, at 1.5 to 2% consistency to a freeness of 400 S.R.

The above methods were used for fiber preparation in the experimental work here reported unless indicated otherwise.

A machine and a method were also described for separating the unhydrated pulp into fractions having the approximate fiber lengths of (a) —0.125 inch, (b) 0.125 to 0.25 inch, (c) 0.25 to 0.50 inch, (d) 0.50 to 0.75 inch and (e) +0.75 inch. Large amounts of these fibers were separated and were then recombined in three component systems to form boards using various proportions of (1) hydrated fiber and (2) —0.125-inch filler fiber, as two of the components, and as the third component the +0.75-inch, 0.50 to 0.75-inch, and 0.25 to 0.50-inch long fibers, respectively. The strength characteristics of the boards resulting were plotted on triangular diagrams. An orderly and regular variation in board characteristics was observed. Density, flexural, and tensile strengths were found to increase as the proportion of hydrated fiber increased. Impact strength increased as long fiber increased. The strongest boards at equal densities resulted with the use of the +0.75-inch next with 0.50 to 0.75-inch, and least with 0.25 to 0.50-inch long fibers. It was concluded that long straw fibers make possible the fabrication of insulating boards of low density and high strength.

The methods of board formation and of testing used in the present study were those described in the first paper of this series (*1*).

Since that time a board machine capable of making a board 23 inches in diameter had become available which made possible samples of board of the size required by the testing methods of ASTM C-209-46T (*3*), Federal Specifications LLL-F-321B (June 30, 1942).

A comparison of the results of the physical tests by the methods of the Northern Regional Research Laboratory on samples from the board made on the 12-inch board machine and tests according to ASTM on samples from the 23-inch boards is presented in Table I.

Taking into account differences in thickness, density, and drying conditions between the 12 and 23-inch boards there appears to be reasonable agreement between the results of the two methods. The impact tests were made on the same size samples cut from the two different sized boards. With more experience in making 23-inch boards it is felt that closer agreement would result, since there was somewhat greater variation between the individual test sample results from which averages were obtained in the case of the 23-inch boards.

EXPERIMENTAL

Establishing Operating Range

Previously the authors (*2*) have shown that it is possible to superimpose specification limits for the physical properties of boards onto a triangular diagram based on fiber components and thus to establish all of the fiber compositions which will comprise boards meeting these specifications.

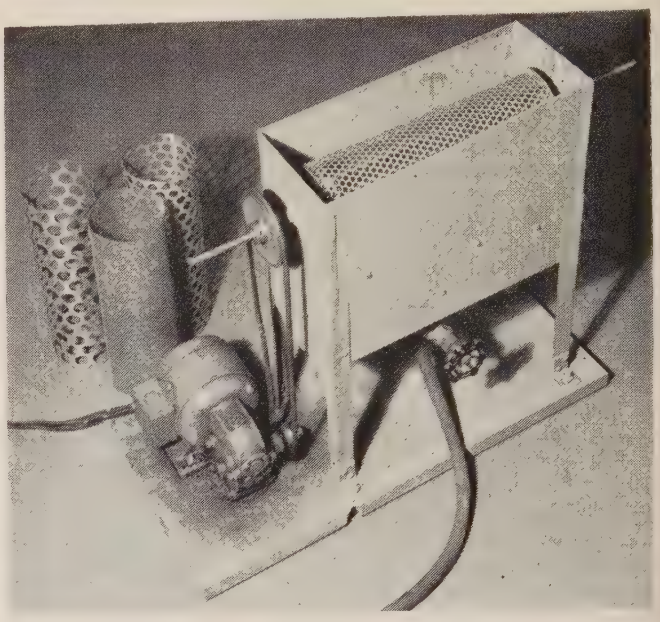

Fig. 1. Small fiber fractionator

The manufacturing operating ranges so established were, however, specific only to long fibers of certain lengths and would not apply directly to two-component systems of unhydrated and hydrated fiber pulps.

Table I. Comparison of Test Results on Samples by NRRL and ASTM Methods. Cut from Boards Prepared from the Same Fiber Composition and Made Under Comparable Conditions

Hydrated fiber, %	*Unhydrated pulp, %*	*Moisture of board into drier, %*	*Thickness, inch*	*Density, g./ml.*	*Flexural strength, p.s.i.*	*Tensile strength, p.s.i.*	*Impact strength, ft.-lb./sq. in.*	*Method of test*
48	52	69.4	0.442	0.298	565	424	2.23	ASTM
48	52	69.2	0.518	0.297	442	459	2.30	NRRL
40	60	69.5	0.400	0.312	489	493	1.52	ASTM
40	60	67.7	0.516	0.294	515	403	1.54	NRRL
35	65	70.4	0.478	0.281	433	356	2.08	ASTM
35	65	67.8	0.534	0.282	486	435	2.08	NRRL
25	75	66.8	0.548	0.236	212	227	1.57	ASTM
25	75	66.3	0.636	0.221	248	215	1.59	NRRL

The fundamental work indicated the desirability of producing a minimum of short or filler fibers in the unhydrated pulp. The time consumed in making a complete fiber fractionation to control manufacture of such pulps made the method impractical. Experience had shown that it is possible to prepare unhydrated pulp with 70 to 80% of the fiber in the range of 0.25 to +0.75 inch. A determination of the per cent of fiber shorter than 0.25 inch seemed practical as a con-

trol step. Accordingly, a small fractionator was built along the same design as the large one previously used (*2*). This fractionator is shown in Fig. 1. The tank containing the rotating screen is 6 by 11 inches. The screens are cylindrical, 3 by 12 inches, and are rotated by a $^1/_{20}$-hp. motor at 25 r.p.m. To make a separation of the —0.25-inch fiber a pulp suspension containing about 15 grams of pulp, moisture-free basis, is introduced into the 0.25-inch hole screen. The cylinder is rotated for 5 minutes with water in the bath to within 1 inch of its top. The bath is drained into a container; the bath is filled again with water and the cylinder again rotated for 5 minutes. The combined suspension of fibers is allowed to stand for a few minutes to permit the majority of fibers to settle. The supernatant water is drawn off by suction through a tube fitted to a stopper with a fritted glass gooch crucible (porosity-B). The settled fibers are washed into a Büchner funnel, collected on a tared filter paper and dried. This small fractionator may be also used for complete fractionation of a pulp sample by using additional cylinder screens having holes of 0.125, 0.50, and 0.75 inch.

Soft red winter wheat straw (Kawvale), combined, free from weeds, with chaff between 2 to 3%, dry when baled, collected in 1947 at Chillicothe, Ill., was used in this study except when stated otherwise. A fiber analysis of this cooked and refined unhydrated pulp (No. 267) is given in Table II.

Table II. Fiber Analysis of No. 267 Cooked and Refined Unhydrated Straw Pulp

Approximate fiber length, inch	*Yield, per cent by weight*	
Less than 0.125	13.1	24.4
Between 0.125 and 0.25	11.3	
Between 0.25 and 0.50	14.6	
Between 0.50 and 0.75	9.2	
More than 0.75	51.8	

It will be noted that fibers less than 0.25-inch long constitute about 25% of this pulp and that the +0.75-inch fraction constitutes 50%. A proportioning calculation shows that the average fiber length of the fraction +0.25 inch is approximately 0.66 inch. The theoretical operating range should lie, therefore, between that previously reported (*2*) for 0.50 to 0.75-inch and +0.75-inch fiber, giving no length value to the 0.125 to 0.25-inch fibers present in the whole pulp. Figure 2 shows this theoretical operating range superimposed on a triangular diagram, the specifications for which are: density 0.20 to 0.30 g./ml., minimum of 200 p.s.i. tensile and flexural strength, and impact strength of not less than 1.5 ft.-lb./sq. in.

In order to check this assumption, boards were prepared from the three components: hydrated fiber, —0.25-inch filler fiber and +0.25-inch long fiber pulp No. 267. The data from this experiment are presented in Table III and are also plotted in Fig. 2. All of the boards meet the specification limits and fit the operating range.

Variations in Unhydrated Pulp Preparation vs. Board Properties

It is obvious that as the proportion of long and short fiber in the unhydrated pulp varies, the area of the operating range will vary. It is to be expected under manufacturing conditions that variations in the operations of cooking and refining the straw will occur, no matter how carefully the operation is controlled. Several batches of Kawvale straw were cooked and refined, therefore, to produce unhydrated pulp which was then made into boards to determine the variations that would result in board properties. The data from this experiment are presented in Table IV. The variation in the amounts of fine fiber produced in the several pulp preparations are shown in the last column of the table. The physical properties of all the boards meet the specification limits and fall within the operating range.

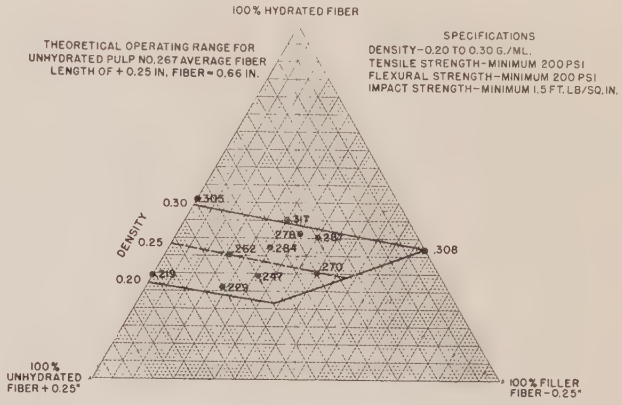

Fig. 2

Table III. Physical Properties of Boards Prepared from Varying Compositions of Pulp No. 267 and Hydrated Fiber

Hydrated fiber, %	*+0.25-inch fiber, %*	*—0.25-inch fiber, %*	*Moisture of board into drier, %*	*Thickness, inch*	*Density, g./ml.*	*Flexural strength, p.s.i.*	*Tensile strength, p.s.i.*	*Impact strength, ft.-lb./sq. in.*
51.0	49	0	70.5	0.474	0.305	736	530	3.25
46.0	54	0	71.6	0.523	0.263	546	390	2.20
45.0	30	25	69.4	0.437	0.317	677	545	2.03
41.0	29	30	72.7	0.518	0.278	567	411	1.58
40.0	25	35	71.1	0.448	0.287	543	426	1.77
38.0	37	25	70.4	0.470	0.284	551	404	2.22
37.0	0	63	70.3	0.518	0.308	629	528	2.17
35.0	20	45	69.7	0.467	0.286	540	426	1.66
30.0	30	40	69.4	0.510	0.270	457	359	1.76
29.0	71	0	70.7	0.543	0.219	299	290	2.32
29	45	26	70.3	0.482	0.247	364	286	1.63
35	49	16	68.9	0.459	0.262	394	344	2.06
26	55	19	69.9	0.499	0.229	295	200	2.11

Variations in Straw Variety vs. Board Properties

Experience at this Laboratory shows that variety,

soil, climate, and season all affect the physical and chemical properties of wheat straw. Variety and location of growth cause the widest variations, but the same variety of wheat grown on the same farm has been found to produce straw that varies slightly in character from one year to the next.

required to express the water from the wet boards to maintain a mositure content to the drier of 69 to 70%. From these results it is clear that the control of the amount of hydrated fiber content of the blend going to the board machine is critical. Furthermore, boards that fail to meet minimum specifications for

Table IV. Physical Properties of Boards Prepared from Kawvale Straw at Different Times

Hydrated fiber, %	*Unhydrated pulp, %*	*Moisture of board into drier, %*	*Thickness, inch*	*Density, g./ml.*	*Flexural strength, p.s.i.*	*Tensile strength, p.s.i.*	*Impact strength, ft.-lb./sq. in.*	*−0.25-inch in unhydrated pulp, %*
30	70	67.0	0.590	0.265	384	349	1.86	23.4
25	75	67.0	0.528	0.250	375	342	2.43	23.4
30	70	70.1	0.500	0.268	555	425	2.66	33.7
25	75	70.4	0.519	0.249	449	376	2.79	33.7
30	70	69.6	0.541	0.242	358	282	2.08	23.4
25	75	69.0	0.473	0.223	252	231	2.19	23.4
25	75	70.0	0.532	0.230	340	256	2.15	28.0

In order to determine the effect of these variations in wheat straw, unhydrated pulps were prepared from four different varieties of straw and the properties of the boards made from these pulps were determined. The three varieties other than Kawvale were:

Rex White, Washington State Agricultural Experiment Station farm, Pullman, Wash., September 30, 1944. Baled dry, free from wheat and weeds, bright in color.

Pawnee Red Winter, Nebraska Agricultural Experiment Station farm, Lincoln, Neb., August 1, 1945. Straw not as bright and clean as Rex White; mice had made tunnels in the bales.

Thatcher Hard Red Spring from Bowbells, N. Dak., October 23, 1946. Straw when received contained considerable wheat, mud, and dirt; mice had made numerous tunnels in the bale and the straw was in bad shape for this study.

The data from this experiment are presented in Table V. The higher per cent of fine fiber (last column in table) produced in the pulp from the Thatcher and the Pawnee samples is a result of the condition of the straw. Even with this wide variation in pulp properties, the physical properties of the boards meet the specification limits and fall within the operating range.

Variations in Hydrated Fiber Content vs. Board Properties

A series of boards was made using unhydrated pulp from Kawvale straw of an analysis similar to that of Table I in which the percentage of hydrated pulp used to make the boards was varied in 5% increments up to 55%. The data from this experiment are presented in Table II. The results are also plotted in Fig. 3. Density and tensile and flexural strength are clearly a direct function of the per cent hydrated fiber. As the amount of hydrated fiber is increased, note from Table VI how rapidly the drainage rate decreases until,

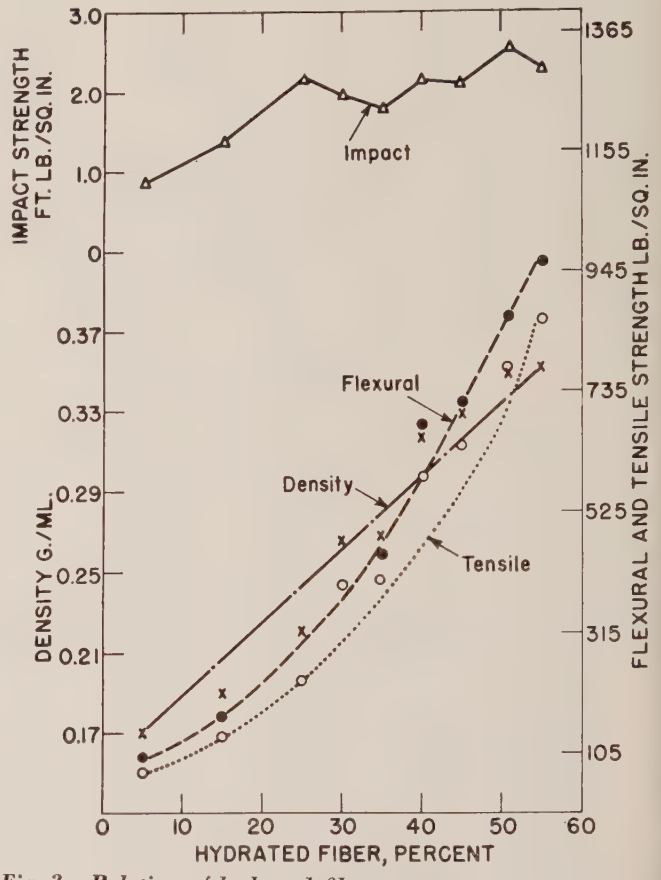

Fig. 3. Relation of hydrated fiber content to physical properties of finished board

tensile or flexural strengths can be made to meet them by slight increases to the furnish of hydrated pulp.

Table V. Physical Properties of Boards Prepared from Four Varieties of Wheat Straw

Hydrated fiber, %	*Unhydrated pulp, %*	*Moisture of board into drier, %*	*Thickness, inch*	*Density, g./ml.*	*Flexural strength, p.s.i.*	*Tensile strength, p.s.i.*	*Impact strength, ft.-lb./sq. in.*	*−0.25-inch in unhydrated pulp, %*	*Straw used*
30	70	70.5	0.435	0.244	424	296	1.53	51.0	Thatcher
30	70	70.8	0.487	0.220	457	305	1.50	38.0	Pawnee
30	70	70.3	0.445	0.239	381	265	1.52	24.4	Rex White
30	70	69.6	0.541	0.242	358	282	2.08	23.4	Kawvale
30	70	69.0	0.512	0.266	459	397	1.98	23.4	Kawvale

at high percentages, formation of such boards would greatly slow down board machine speeds. In the column "pressure used" will be found the pressures

There is some rise in impact strength with increasing percentage of hydrated pulp, but this property is mainly dependent of the presence of long fibers.

Variation of Moisture Content of Board into Drier vs. Board Properties

It is well known that the moisture content of boards entering the drier has an important effect on the physical properties of the resulting board. Low density boards can be made from almost any fiber if the board is dried at a high enough moisture content. From the standpoint of costs it is desirable to dry at a moisture content as low as the character of the fiber will permit meeting density requirements.

In the previous experiments the moisture content of boards entering the drier was controlled at close to 70%. The data in Table VII which are plotted in Fig. 4 show the effect of pressing boards, made from the same blend of unhydrated and hydrated pulps, to varying and lower moisture contents before drying. It will be noted that density and flexural and tensile strengths increase as a direct function of the dryness of the board. Impact strength is not greatly affected by the dryness of the board, this propertiy being dependent primarily on fiber length.

A comparison of the data plotted on Figs. 3 and 4 shows that approximately the same increase in density, and in flexural and tensile strength is produced by reducing the moisture content from 70 to 52% (Fig. 4) as by increasing the amount of hydrated fiber from 25 to 35% (Fig. 3). By compacting the board to reduce the moisture content fiber bonding is improved. Data are presented in Table VIII on boards made from 20, 25, and 30% hydrated fiber and pressed to varying moisture contents before drying. It will be observed that boards prepared with 20% hydrated fiber and pressed to 61 and 53% moisture content have low densities and excellent strength characteristics. In terms of the operating range shown in Fig. 2, based on pressing boards to 70% moisture content, the effect of pressing the boards to 60 or 53% would be to coordinately lower the operating range on the triangular diagram toward the bottom. For example, between 15 to 17% hydrated fiber at 53% moisture should

Table VI. Physical Properties of Boards Prepared from Kawvale Unhydrated and Hydrated Pulps[a]

Hydrated fiber, %	*Unhydrated pulp, %*	*Draining time, sec.*	*Pressure used, p.s.i.*	*Moisture of board into drier, %*	*Thickness, inch*	*Density, g./ml.*	*Flexural strength, p.s.i.*	*Tensile strength, p.s.i.*	*Impact strength, ft.-lb./sq. in.*
5	95	225	70	69.0	0.565	0.170	98	70	0.87
15	85	231	60	70.0	0.473	0.190	168	133	1.38
25	75	395	50	69.0	0.473	0.223	252	231	2.19
30	70	515	70	69.0	0.512	0.266	459	397	1.98
35	65	670	70	69.6	0.499	0.268	450	406	1.78
40	60	693	100	68.0	0.482	0.317	674	592	2.17
45	55	855	100	69.0	0.475	0.328	714	640	2.16
51	49	1892	120	69.5	0.434	0.349	868	774	2.57
55	45	1884	100	69.7	0.424	0.352	963	860	2.30

[a] Unhydrated pulp contained 23.4% of −0.25 inch.

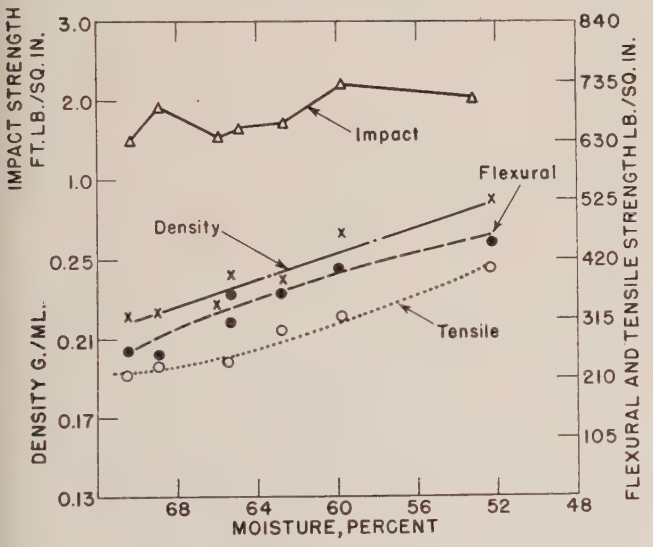

Fig. 4. Relation between physical properties of board and moisture content before drying

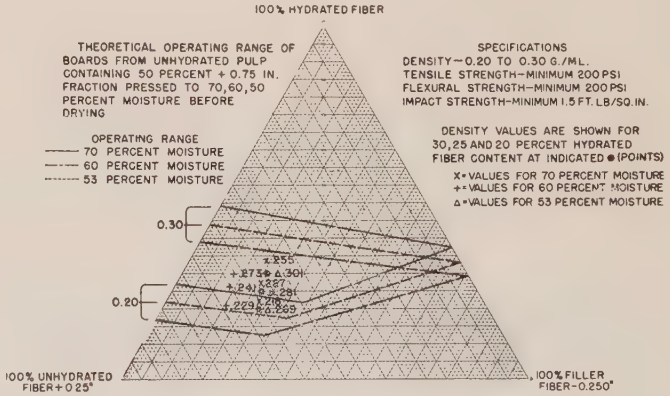
100% HYDRATED FIBER
THEORETICAL OPERATING RANGE OF BOARDS FROM UNHYDRATED PULP CONTAINING 50 PERCENT + 0.75 IN. FRACTION PRESSED TO 70,60,50 PERCENT MOISTURE BEFORE DRYING
OPERATING RANGE
70 PERCENT MOISTURE
60 PERCENT MOISTURE
53 PERCENT MOISTURE
SPECIFICATIONS
DENSITY—0.20 TO 0.30 G./ML.
TENSILE STRENGTH—MINIMUM 200 PSI
FLEXURAL STRENGTH—MINIMUM 200 PSI
IMPACT STRENGTH—MINIMUM 1.5 FT. LB/SQ.IN.
DENSITY VALUES ARE SHOWN FOR 30,25 AND 20 PERCENT HYDRATED FIBER CONTENT AT INDICATED ● (POINTS)
×=VALUES FOR 70 PERCENT MOISTURE
+=VALUES FOR 60 PERCENT MOISTURE
Δ=VALUES FOR 53 PERCENT MOISTURE
0.30
0.20
100% UNHYDRATED FIBER+0.25"
100% FILLER FIBER-0.250"

Fig. 5

Table VII. Physical Properties of Boards Pressed to Different Moisture Contents Before Drying

Hydrated fiber, %	*Unhydrated pulp, %*	*Moisture of board into drier, %*	*Thickness, inch*	*Density, g./ml.*	*Flexural strength, p.s.i.*	*Tensile strength, p.s.i.*	*Impact strength, ft.-lb./sq. in.*	*−0.25-inch in unhydrated pulp, %*
25.0	75.0	69.0	0.473	0.223	252	231	1.94	23.4
25.0	75.0	70.4	0.493	0.222	260	214	1.49	24.4
25.0	75.0	65.3	0.448	0.243	361	239	1.66	24.4
25.0	75.0	59.8	0.416	0.263	407	318	2.22	24.4
25.0	75.0	66.0	0.578	0.227	313	239	1.55	29.5
25.0	75.0	62.8	0.530	0.241	359	292	1.72	29.5
25.0	75.0	52.2	0.464	0.281	451	407	2.04	29.5

Table VIII. Physical Properties of Boards Made from Different Percentages of Hydrated Fiber and Dried at Varying Moisture Content in Forced Air Oven

Hydrated fiber, %	*Unhydrated pulp, %*	*Draining time, sec.*	*Pressure used, p.s.i.*	*Moisture of board into drier, %*	*Thickness, inch*	*Density, g./ml.*	*Flexural strength, p.s.i.*	*Tensile strength, p.s.i.*	*Impact strength, ft.-lb./sq. in.*	*Minimum drying time, min.*
30	70	458	110	67.1	0.615	0.255	347	218	1.85	95
30	70	502	160	62.8	0.548	0.273	444	329	1.92	71
30	70	510	400	54.1	0.430	0.301	589	443	2.10	47
25	75	300	100	66.0	0.578	0.227	313	239	1.55	86
25	75	296	130	62.8	0.530	0.241	359	292	1.72	70
25	75	285	400	52.2	0.464	0.281	451	407	2.04	47
20	80	234	90	67.1	0.592	0.218	302	207	1.32	92
20	80	241	160	61.1	0.520	0.229	285	256	1.59	70
20	80	255	360	53.1	0.490	0.269	424	311	2.16	43

produce a board meeting the minimum specifications required by the range, providing the impact strength is met by the use of unhydrated pulp having at least a 50% +0.75-inch fiber fraction. Figure 5 shows the probable operating ranges for boards with 70, 60 and 53% moisture content made from unhydrated pulp having a 50% +0.75-inch fiber fraction.

The fiber analysis of the unhydrated pulp used to obtain the data in Fig. 8 is shown in Table IX.

Table IX. Fiber Analysis of Unhydrated Pulp No. 276

Approximate fiber length, inch	*Yield, per cent by weight*	
Less than 0.125	11.3	29.7
Between 0.125 and 0.25	18.4	
Between 0.25 and 0.50	21.5	
Between 0.50 and 0.75	6.3	
More than 0.75	42.5	

It will be noted that this pulp fails to meet the above requirements in percentage of 0.75-inch fiber. This deficiency accounts for the low impact strength, 1.32 ft.-lb./sq. in., of the board made with 20% unhydrated fiber, the board being pressed to 67% moisture content. The improved fiber bonding produced at higher pressures and lower moisture contents give impact strengths which meet 1.5 ft.-lb./sq. in., although density also increases.

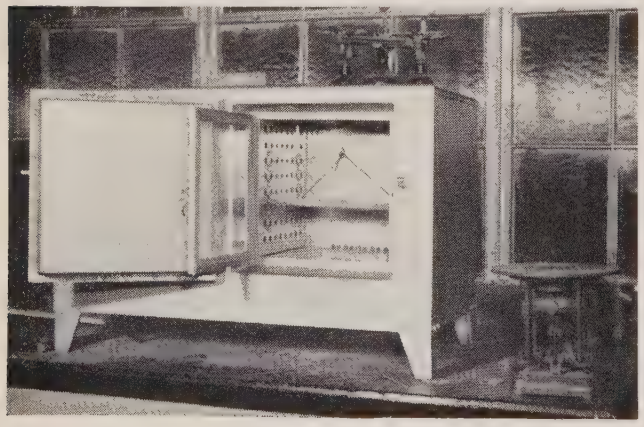

Fig. 6. Small forced-draft, electrically heated oven

Moisture Content of Board vs. Drying Rate

Drying is costly in board manufacture. From the standpoint of capital investment in drying equipment and of daily operating costs it is important to transfer from the board machine to the drier a product as dry as possible.

The effect of moisture content on drying rate was determined on a series of boards made from unhydrated pulp No. 276 (Table IX) and 20, 25, and 30% of hydrated fiber. The wet boards were pressed to three moisture contents between 50 and 70%.

The forced-draft, electrically heated oven, having inside dimensions 12 by 12 by 14 inches used for the study is shown in Fig. 6. The board was suspended inside the oven from one arm of a balance above and was weighed every 5 minutes during drying until the board came to moisture content of 3% or slightly less.

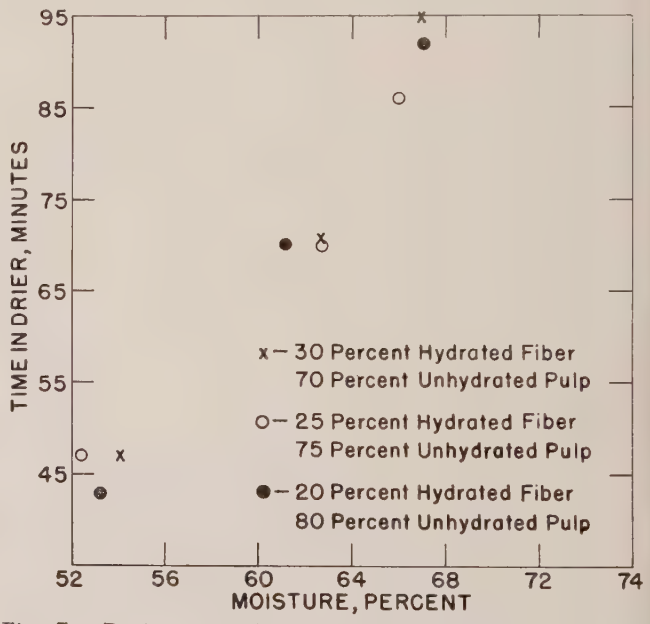

Fig. 7. Drying time for boards made with 30, 25, and 20% hydrated fiber, pressed to approximately 67, 62, and 53% moisture content before drying

During the first 20 to 25 minutes, depending on drying rate, the temperature was held at 240°C. and was then dropped to 180°C. to prevent burning the board. By means of a fan a draft of 400 ft./sec. of air was maintained across the surface of the board during drying.

The data from this experiment are presented in Table VIII and plotted in Fig. 7. The drying time of boards with 53 to 54% moisture content is about half that of those with 70% moisture and with 60% moisture about two-thirds that with 70%, taking into account differences in thickness of the boards. It will be noted in general that as the percentage of hydrated fiber in the boards decreases, drying time is less.

The moisture content of insulating board made from wood fiber going to the drier is in the range of about 65 to 70%. It is possible to manufacture board from

sugarcane bagasse with a density of 0.25 or less with a moisture content into the drier of 52 to 55%. From the data given, straw fiber appears the equal of bagasse in this respect. The long springy character of these fibers, as compared with the shorter and less springy character of wood fibers, is responsible for this situation.

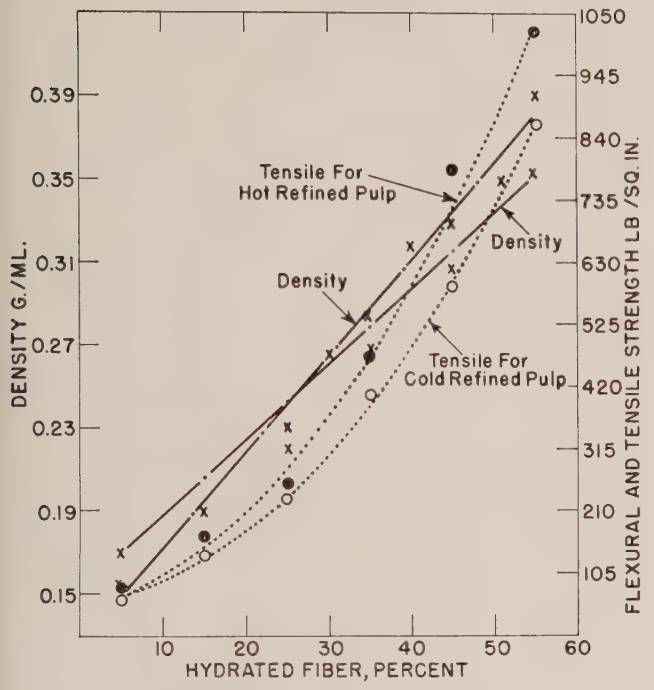

Fig. 8. Effect of temperature during refining on density and tensile strength of boards

Table VIII shows the pressures required to produce the various moisture contents of the boards. This has an important bearing on board machine press design. Presses designed to press the board to 50 to 55% moisture will permit smaller driers and greatly reduced drying costs. Because considerably less hydrated fiber is needed for such low moisture boards to produce strength requirements, drainage on the forming machine will be more rapid, permitting faster board machine operation. In turn, savings will result in cooking and refining fiber, since the cost of the hydrated fiber is the greater of the two.

Hot vs. Cold Refining of Unhydrated Pulp

In the preparation of unhydrated pulp up to this point it was passed through the Bauer refiner cold to attain coarse, long fibers. It had been thought that long fibers of greater diameter would favor impact resistance. Power for refining is always high. Refining hot takes somewhat less power than cold, and trials had shown that a finer diameter of fibers was produced and also that it was somewhat more difficult to control the length of fibers in hot-refined pulp.

To determine whether hot refining was permissible, chopped straw was cooked in water for the standard time in the 3-foot rotary digester. Half of the cooked straw was allowed to cool and was refined cold at a clearance between the plates of about 0.025 inch. The other half was refined at 60 to 65°C. In order to obtain a satisfactory pulp at this temperature, plate settings were 0.030 to 0.035 inch. Both pulps were refined at as near 8% consistency as possible, and were passed through the rotary washer. The two unhydrated pulps were then made into a series of boards. The data from this experiment are given in Table X and are plotted in Figs. 8 and 9. From these data it is

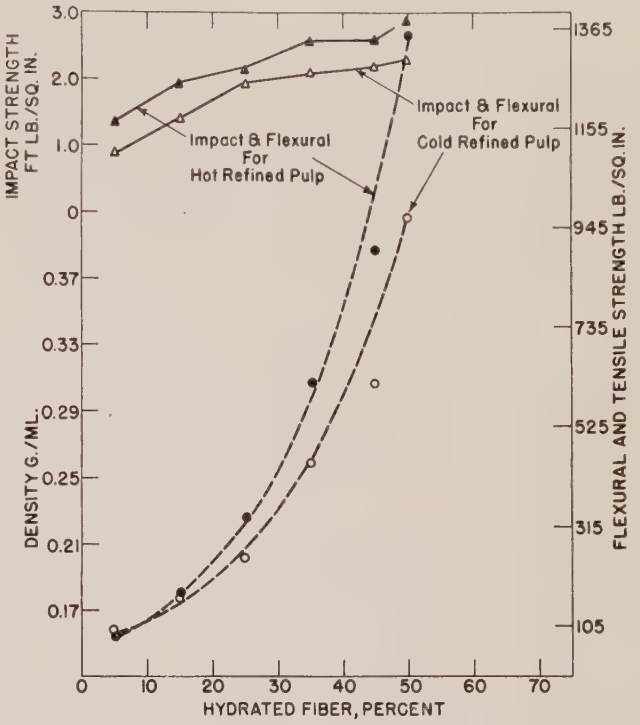
IMPACT STRENGTH FT LB./SQ. IN.
DENSITY G./ML.
FLEXURAL AND TENSILE STRENGTH LB./SQ. IN.
HYDRATED FIBER, PERCENT
Impact & Flexural For Hot Refined Pulp
Impact & Flexural For Cold Refined Pulp

Fig. 9. Effect of temperature during refining on flexural and impact strengths

Table X. Physical Properties of Insulating Boards Prepared from Hot- or Cold-Refined Unhydrated Pulp

Hydrated fiber, %	*Unhydrated pulp, %*	*Moisture of board into drier, %*	*Thickness, inch*	*Density, g./ml.*	*Flexural strength, p.s.i.*	*Tensile strength, p.s.i.*	*Impact, strength, ft.-lb./sq. in.*
5	95	69.0	0.565	0.170	98	70	0.87
5*	95	70.3	0.600	0.153	81	68	1.31
15	85	70.0	0.473	0.190	168	133	1.38
15*	85	70.4	0.422	0.191	175	170	1.93
25	75	69.0	0.473	0.223	252	231	1.94
25*	75	70.0	0.532	0.230	340	256	2.15
35	65	69.6	0.499	0.268	450	406	2.08
35*	65	68.9	0.452	0.284	616	470	2.58
45	55	69.8	0.492	0.308	616	582	2.20
45*	55	69.5	0.445	0.328	898	785	2.58
55	45	69.7	0.424	0.352	963	860	2.30
55*	45	69.3	0.367	0.390	1353	1018	2.89

Cold-refined pulp contained 24.4%—0.25 inch.
Hot-refined pulp contained 28.0%—0.25 inch.
* Refined at 60°C. others at 25° C.

evident that the hot-refined pulp is somewhat superior to the cold-refined pulp. This shows up particularly in impact and flexural strength. While the hot-refined pulp is somewhat higher in +0.25-inch long fibers, the density of the boards made from it are in general slightly lower. There is, therefore, both a cost and a quality advantage in refining the pulp hot.

Fiber Preparation by Atmospheric Cooking and Continuous Refining

Recent preliminary work at this Laboratory (*4*) has shown that surprising results in pulping straw can be obtained by cooking at atmospheric pressure when the fibers are at the same time subjected to high impact forces. These results can be obtained in degree by cooking in an open can in which impact is supplied by a high-speed stirrer. There are a number of pulpers in use in paper mills where this principle is used to disintegrate waste paper or baled pulp. Our first experimental studies have been carried on cooperatively with a strawboard mill, using a 3-foot Hydrapulper.* As noted below, Aronovsky and Lathrop found that pulp for strawboard manufacture could be prepared with the standard amounts of lime and caustic with a 1-hour cook.

Experiments were therefore made on the preparation of unhydrated pulp by this method. The straw was chopped as usual and was fed into the Hydrapulper, which contained water and 2% of calcium oxide (dry straw basis), to give 8% consistency. At the end of 30 minutes' cooking, using live steam, the pulp was drained and refined hot through the Bauer refiner at 8% consistency. The pulp was washed in the rotary washer, and a washed pulp yield of 82% was obtained. This pulp was used with hydrated pulp prepared by pressure cooking and beating to prepare a series of boards of varying hydrated fiber contents. Boards of the same hydrated fiber content were pressed to moisture contents of 69, 60, and 53% before drying. The data obtained on the physical properties of the boards are plotted in Fig. 10 which also shows the fiber analysis of the pulp. It will be noted that the pulp is somewhat low in percentage of 0.75-inch fiber, but by making some adjustments in refining there is no doubt that suitable unhydrated pulp can be made in this way. The curves in Fig. 10 are to be compared with those of the hot-refined pulp in Figs. 8 and 9. The effect of drying the board at various moisture contents checks closely with results obtained in the experiments with pressure-cooked and cold-refined unhydrated pulp.

* Mention of firm names, their equipment, or products is for information only, and does not constitute an endorsement.

It was found possible, based on the work mentioned, to prepare satisfactory hydrated pulp by adding chopped straw to the Hydrapulper containing an almost boiling solution of 6% calcium oxide and 1.5% sodium hydroxide (basis moisture-free straw). The straw wilted as soon as it hit the hot solution and was added to obtain a consistency of 9% and then cooked for 1 hour. The pulp was drained and was hydrated (1) by beating in the usual manner and (2) by passing through the Bauer refiner. A yield of 75% hydrated pulp was obtained. Portions of the cooked pulps were hydrated at different pH values. Two separate cooks were made in the Hydrapulper. The pulps atmospherically cooked and hydrated in various ways were compared by making TAPPI hand sheets with pulp cooked under pressure and beaten to a freeness of 400SR. The data from these experiments are given in Table XI. The atmospheric-cooked and beaten pulps at pH about 8 are satisfactory, as compared with standard, and could be beaten to a somewhat lower freeness. The strengths of the pulps obtained by hydration with the Bauer show considerable variation due to variations in consistency and pH of the pulps during refining. The pulp marked ([a]) produced satisfactory strong hand sheets. This pulp and pressure cooked, beater-refined hydrated pulp were compared for board-making properties by blending these pulps in proportions of both 22.5 and 25% with atmospheric-cooked, hot-refined unhydrated pulp. The physical properties of the respective boards were almost identical. More work should be carried on in relation to attrition mill refining. This is now the subject of cooperative research between the Northern Regional Research Laboratory and the strawboard industry.

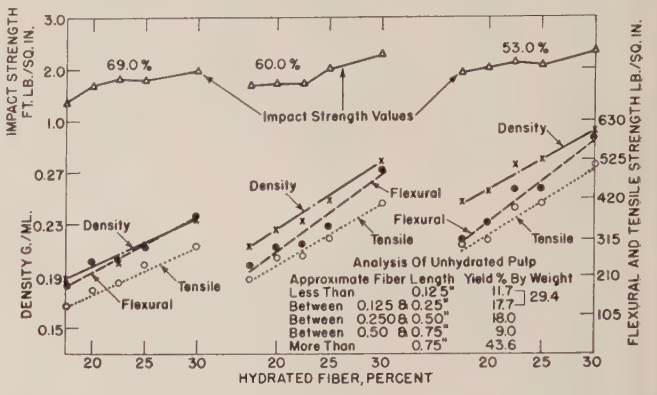

Fig. 10. Physical properties of boards made with atmospheric cooked hot refined, unhydrated pulp and various percentage of hydrated fiber, dried at moisture contents of 69, 60, and 53%

Table XI. Physical Properties of Paper Sheets Formed from Hydrated Fibers Prepared in Different Ways

Method of Cooking	Method of Refining	Consistency during refining	pH during refining	Freeness S.R.	3 g. sheets Basis weight	Density	Burst	Tear/ream	Tensile/ream
Pressure	Beater	1.56	7.8	400	115.3	0.640	56.0	45.4	120.6
Atmos.	Beater	2.67	7.8	440	118.4	0.660	61.7	59.5	112.4
Atmos.	Beater	1.56	8.3	440	114.7	0.620	65.4	67.0	104.6
Atmos.	Beater	1.80	7.6	410	119.7	0.629	59.0	66.8	101.0
Atmos.	Bauer[a]	1.97	7.8	440	120.6	0.590	53.9	74.4	102.0
Atmos.	Bauer	2.39	9.6	370	114.1	0.631	45.5	67.3	126.2
Atmos.	Bauer	4.2	7.6	520	117.3	0.519	41.8	78.2	89.5

Drying in the Hydraulic Press to Make Dense Boards

In order to determine the strength properties of boards having densities of 0.50 or higher, such as quarter board or denser products, a blend of 20% hydrated fiber and 80% of atmospheric-cooked, hot-refined unhydrated pulp No. 284 was used to make a series of boards which were dried between electrically heated platens in a hydraulic press. The data from this experiment are plotted in Fig. 11. The same weight of blended pulp was used to make each of the five boards which were pressed in the cold to a 60% moisture content before drying. Stops were used in the press to control finished thickness as follows: 0.53, 0.25, 0.188, 0.164, and 0.125. Screens, 16 by 18 mesh, were on the top and the bottom of the boards during drying. From these data it is evident that at

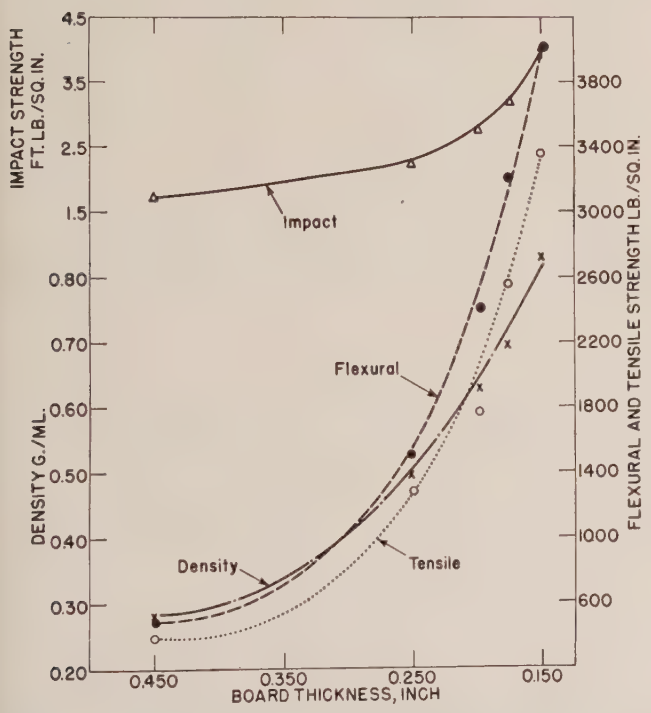

Fig. 11. Physical properties of boards prepared from atmospheric cooked and hot refined, unhydrated pulp No. 284 dried in the press to different thicknesses

the respective densities boards of good strength can be made by pressure drying to a controlled thickness.

PROCESS DETAILS AND CONTROLS

Straw

Methods of collecting, transporting, storing, and handling straw into the mill are standard practices in the strawboard industry which uses about 600,000 tons of straw annually. The practice of combining wheat has practically eliminated the farm straw stack. Satisfactory pick-up balers for making a wire-tied bale having a density of not less than 9.3 lb./cu. ft. are available in increasing quantities. Some mills are now storing part of their supply in straw ricks in the country. Improvements have been made in storing straw by sprinkling powdered borax over the bales in the three top tiers of the rick. This method has resulted in almost perfect preservation of the straw during storage for a year or two, and has resulted in saving straw worth $300 to $400 per 400-ton rick. The strawboard industry is actively engaged in improving these collection and handling procedures.

Two Pulps Required

Two different types of pulps require preparation. By controlled blending of these pulps it is possible to produce building boards of a wide range of densities and with exceptionally good physical strength at comparable densities. Impact strength, associated with ruggedness in handling the board, is much higher than that of presently manufactured boards made from wood, and compares favorably with boards which may be made from sugarcane bagasse. While fairly satisfactory boards may be made by water cooking and attrition-mill refining of wheat straw, these tend to be of high density unless strength is sacrificed. The range of products possible is limited because of inability to produce sufficient hydration and to control the degree of hydration.

Chopping Straw

It is shown that both pulps may be produced either by pressure or atmospheric cooking. In either case the straw should be chopped to about 1.5 inch in length, passed through a rotary Trommel dressed with about 20-mesh screen to remove fine dust and dirt, and blown through a cyclone to remove chaff and grain. It then goes directly to the cooker or into a storage bin to feed the cooker. This bin should be provided with a vibrator to cause the straw to flow. Depending on the cleanliness of the straw, losses due to dirt and chaff in good combine straw should run not more than 2.5 to 3.0%. From bale weights and moisture content of straw a digester charge can be accurately controlled with necessary checks for dust and dirt losses on standard straw deliveries.

While a farm-type ensilage cutter has proved satisfactory for pilot-plant chopping, such machines are believed to be not rugged enough for continuous large-scale production. Straw choppers have been in use in Europe and South America for many years. Several companies in the United States, with the cooperation of the strawboard industry, are studying the development of rugged straw choppers. A Canadian mill has been experimenting with one of these machines and expects to use it in production as soon as a satisfactory breaker for frozen bales is available. A suitable chopper may be expected in the near future.

Cooking

For cooking under pressure the standard spherical rotary digester in sizes 14 or 18 feet in diameter is available. If this procedure is used for water cooking to produce the unhydrated fiber, a conveyor is required to deliver the hot, drained straw to the disk refiner.

The procedures available for cooking and handling the hydrated fiber are those now used in the strawboard industry. It is desirable to pass the cooked and drained straw through some type of dewatering press to remove as much of the concentrated alkaline cooking liquor as possible. The sugar mill roll press is now in use for this purpose in some mills. The concentrated alkaline cooking liquor drained from the

cooker and that separated from the dewatering press are combined and treated to eliminate stream pollution.

Pilot-plant studies have shown that the atmospheric method of cooking is more rapid and is capable of savings in labor and steam. There are several commercial pulpers which will probably prove satisfactory, as now made or with some modifications in design. In any case, tests on a larger scale than those reported should be made to insure that a suitable fiber can be prepared to determine cooking times, steam consumption, and power usage. Several tests of this sort are now scheduled by equipment manufacturers in cooperation with this Laboratory and the strawboard mills.

Washing

The unhydrated pulp is washed and thickened after disk refining. A convenient machine for this purpose is a revolving Trommel screen having an inside helical screw to move the pulp. Screens having holes 0.04 inch in diameter are satisfactory, but the effluent from the screen should be passed over a hillside screen of 100-mesh or a save-all to recover fine fibers, which are added back to the pulp. The holes of the screen at the feed end are kept clean by a shower. White water from this pulp can be used for cooking and for dilution water in stock chests.

The hydrated fiber after atmospheric cooking may be thickened and washed on a continuous filter. The concentrated caustic liquor should be kept separate. It can be re-used for cooking, but excess should be treated separately to minimize stream pollution. The wash water may also be used in cooking hydrated or unhydrated pulp. Hydrated fiber, when prepared from whole or chopped straw by pressure cooking and beating, is washed in the beater preferably after a dewatering operation. It may be possible to continuously refine the pulp from the dewatering press, using means to defiber it before feeding to a disk refiner. This pulp from the dewatering press appears to be too coarse to permit of one-pass refining in a disk refiner.

Refining

The unhydrated pulp is refined as hot as possible through a disk refiner to obtain a pulp containing about 50% +0.75-inch long fibers and about 25% —0.25-inch fibers. A simple and quick control method is to suspend a small sample of a standard pulp in water in a glass pie plate and to match visually the standard with samples obtained after making the necessary adjustments in the plate setting of the refiner. The small fiber fractionator may be used as a check test, particularly when difficulty in refining is experienced. Pulp is fed to the refiner at 8% consistency or higher, if possible, in order to increase capacity and reduce power costs.

The hydrated fiber may be beaten to 400 S.R. freeness in the beater, or may be hydrated in one of the various makes of disk refiners. Before deciding on the refiner, performance tests should be made to determine optimum operating conditions, such as maximum consistency of refining production rate, power consumption, plate life, and other factors. While freeness is a good operating guide, the strength of standard test handsheets, especially bursting strength, is the most accurate method of evaluation.

Blending

The two pulps after refining are pumped to different chests. The calculated amount of size or other chemical may be added at this point, based on the consistency of the pulps, which should be about 3.0 to 3.5%. For proper results the pulps must be blended in a continuous fashion. This is easily accomplished by pumping the pulps through consistency regulators to small metering headboxes with return over-flows to the chests. The metering device should be set to deliver as accurately as possible the required weights of each pulp. The two pulps should flow into a fan pump, stock pump, or board machine refiner, such as a jordan or claflin, so as to obtain instantaneous and violent mixing. The proportioned pulp may be delivered to a machine chest or directly to the machine. Alum or alum and sulphuric acid, if required by an alkaline pulp suspension, or other chemical agents may be proportioned into the stock during the blending.

The experiments described do not indicate the necessity of brushing out the fiber before going to the board machine, but equipment for this purpose is indicated for smoother board machine operation. Cutting or shortening the fiber to any appreciable extent must be avoided.

Board Machine

As discussed previously, the press section of the board machine should be capable of expressing the water from the board to a moisture content of 50 to 55%. This will permit the use of the lowest amount of hydrated fiber to produce boards of required densities and strengths and will result in more rapid drainage as well as faster running of the board machine. The pulp will form satisfactorily on any of the commercial machines. Because of the long fiber character of the pulp, formation of the board will tend to be less uniform and lumpier than with wood fiber pulps. This can be offset by dilution of the stock to lower consistencies in the head box, thus minimizing eddy currents. The machine should be designed, therefore, to handle consistencies lower than standard for wood fiber. Freeness determinations using the modified Schopper-Riegler tester (*1*) will prove a useful control for drainage rates on the board machine.

Two means exist for modifying pulp characteristics when boards fail to meet specification limits. (1) Addition of hydrated fiber will bring about increases in density and tensile and flexural strength. Provision may be made for introducing hydrated fiber through a line directly to the suction side of the stock pump to the board machine, so that a small amount of metered hydrated pulp can be added until a change in the blend in the machine chest has been effected. (2) Impact strength will be increased by increasing the percentage of +0.25-inch fibers in the unhydrated pulp. This, in turn, will tend to reduce the percentage of hydrated fiber required to meet density specifications.

Drying

The board may be dried in the continuous tunnel

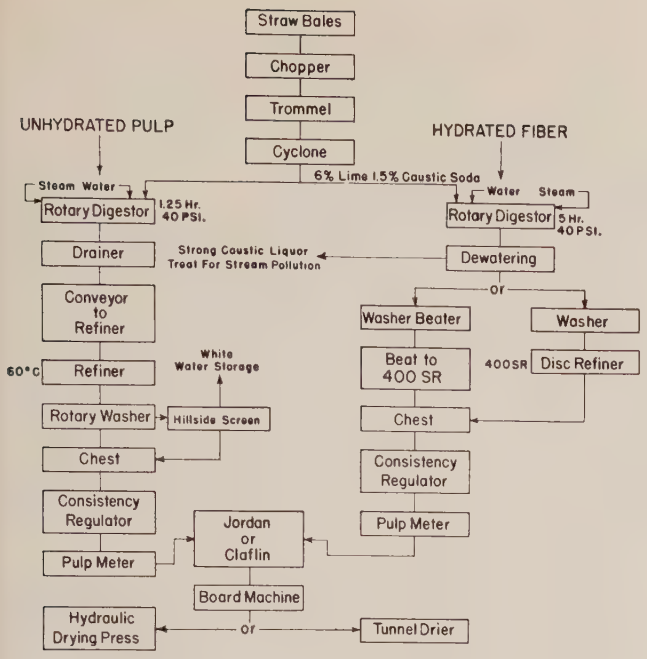

Fig. 12. Flow sheet using pressure cooked straw

driers or in multiplaten hydraulic presses to a low moisture content in order to set the waterproofing agents. The design and operating characteristics of these machines are well known.

Finishing

The board should be sprinkled with water on emerging from the drier to a moisture content of 8 to 10%, to season it after piling, and to insure stability of dimensions. It may be cut, fabricated, or finished into any of the standard forms or finishes.

Figures 12 and 13 give flow sheets of the alternate processes for board manufacture.

ECONOMICS

Straw

Farm uses for straw must always receive first consideration. The maintenance of soil fertility is paramount. Changing economic conditions must, however, change our thinking. Agronomists were pleased when the combine came into the Middle Western States, because this probably meant return of the straw to the soil, a practice not observed with the straw stack. It has now been discovered in the states growing soft winter wheat where legumes follow the wheat to provide hay and green manure, that the combine straw and stubble may reduce the legume yield from 30 to 60%. Moreover, yields of wheat are on the increase in this area. Agronomists (*5*) now recommend removal of the straw from such fields promptly. If the straw has farm uses it should be kept; if not, an industrial market should be sought. During the war suitable pick-up balers were not generally available but the situation today is greatly improved. This year most of the strawboard mills were able to secure their straw within a radius of 150 miles, some within 75 miles. It is believed that these distances will diminish with the better relations which are taking place between farmers and the mills.

Depending on distance of transportation, mills last year paid from $12 to $14 per ton for clean baled straw at the mill. Farmers received about $3 per ton for the straw in the field. If the farmer baled, hauled, or stored the straw his return was greater.

Last year 95 million tons of wheat straw were grown in this country of which about 3 million tons were baled. It is difficult to determine how much was burned or wasted. Statistics account for the use of only about half of this tonnage. A farmer in North Dakota recently wrote that he burned 41 large straw stacks last year. In the Middle Western States there appears to be more than a million tons of excess straw. There is no shortage of straw.

It is believed that straw prices in areas of excess straw are at their peak, and that better methods of collection and handling, which are possible, will bring lower costs.

Process Costs

It is not possible to present a complete estimate of cost of manufacture. This can only result from a complete engineering study. The process differs only in raw materials, and cooking and refining of pulps from standard commercial operations. The following items of cost can be estimated.

Unhydrated pulp 80% yield—atmospheric cook:	
2500 lb. straw at $14 ton	$17.50
50 lb. lime (2%) at $10 ton	0.25
Raw materials cost per ton air-dry pulp	$17.75
Hydrated pulp 75% yield—pressure or atmospheric cook:	
2660 lb. straw at $14 ton	$18.66
160 lb. lime at $10 ton	0.80
40 lb. caustic soda at 3¢ lb	1.20
Raw materials cost per ton air-dry pulp	$20.66

A board composition of 75% unhydrated and 25% hydrated pulp would have a raw materials cost of

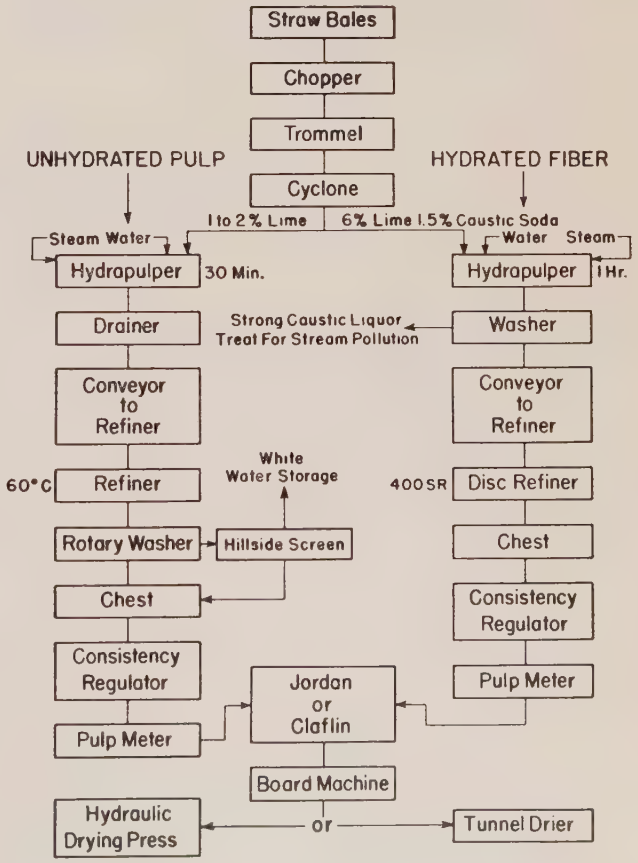

Fig. 13. Flow sheet using atmospheric cooked straw

$18.45 per air-dry ton. On the basis of 3000 square feet of $^1/_2$-inch board per ton of pulp, the cost of raw materials per 1000 square feet $^1/_2$-inch board would be $6.15. Steam and power requirements for cooking and refining these pulps will depend on the methods and equipment chosen. The atmospheric methods of cooking have higher power costs than pressure cooking but a distinct saving of labor and steam should result. With a relatively free pulp, board-machine speeds should be average or above and drying costs will be much lower than average. In view of these considerations it is believed that manufacturing costs for producing the boards described will compare favorably with present practice.

There are much data at the Laboratory bearing on plant design and costs. The authors welcome an opportunity to cooperate with or assist anyone seriously interested in undertaking large-scale industrialization of the products.

SUMMARY AND CONCLUSIONS

Fundamental studies into the relationships of fiber length and fiber hydration of wheat straw showed clearly that high-quality building board products could be manufactured from it.

In the present study the rather exact effect of the important operating variables in the use of straw in board manufacture have been carefully explored to determine how far it is practical to bring operations from more-or-less rule of thumb to a more exact science.

This study has resulted in showing clearly the direct steps in control necessary, either to produce products of certain definite properties, or to remedy failures during operations to meet specified properties.

Having in mind clearly the limits and implications of a known operating range, the technical superintendent can, with straw fiber, operate on the basis of exact facts with a very small amount of control.

Straw pulp, unhydrated, can be easily produced to contain 50% of $^3/_4$-inch fibers. The use of this pulp results in a wide operating range, so that minor operating variations are not critical.

The incorporation of separately produced hydrated pulp greatly increases the range of products which may be made with simple blending control, and also makes possible quick correction of board strength deficiencies in board manufacture.

Straw contains no pith and in this respect is superior to the use of residues containing pith, such as sugarcane bagasse. It equals bagasse in producing long, springy, resilient fibers. Like bagasse it produces boards several times higher in impact strength than similar products from wood pulp. High-impact strength assures ruggedness and handleability.

Wheat straw is, therefore, an outstanding raw material for the manufacture of high-grade building board products. It is believed that the costs of such products would prove competitive with present large-scale industrial manufacture.

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Continuous Cooking of Kraft

JOHAN RICHTER

A Kamyr pilot plant of 8 tons per 24 hour capacity has been successfully operated for continuous cooking of kraft. The quality of the product, the economy of the process, and the initial installation costs compare favorably with the batch system. The operation has proved extremely flexible, reducing man power to a minimum. The steam consumption is less than 2000 pounds of steam for 1 ton of pulp. Details on the development and construction of the plant are given.

The problem of continuous digestion of fibrous materials has attracted inventors for years, and although a great number of patents have been applied for and granted, but few have materialized.

A/B Kamyr started working on the problem ten years ago, in 1938, and six years passed before the pilot plant was able to produce normal kraft pulp, and two more years before certain delicate parts were quite satisfactory thereby permitting a regular operation of the plant. During all these years Kamyr had the great privilege of collaborating with the Swedish States Wood Industries Organization, proprietor of the Karlsborgs kraft mill where the pilot plant was installed. The big mill furnished chips, liquor, steam, power, etc., as well as operators. Pulp and black liquor were to be returned in exchange. This original pilot plant had to be totally rebuilt twice before the solution was reached.

Johan Richter, Chief Engineer, A/B Kamyr, Karlstad, Sweden.

THE PILOT PLANT

The initial installation was designed for two-stage cooking with intermediate washing under digester pressure (Fig. 1) and was based on experiences in continuous bleach plants, completely neglecting the problems involved when handling chips instead of fibers.

By means of a plunger the chips were fed from a bin into an impregnation vessel in open connection with the top of digester No. 1. The precooked pulp was

Table I. Sulphite Cooks with Approximately Equal Chlorine Numbers

Extract of P.F.I.'s Report of the May 22, 1942. Reg. No. 4045/46

Test (Chips picked):	*A Before plunger*	*B After plunger*	*C Before screw*	*D After screw*
Oslo chlorine number	1.88	1.81	2.09	1.81
Breaking length	10,670	4925	9375	3280
Burst	62	24	57	13
Tear	76	44	73	34
Double folds	3,650	55	3425	2

Frithjof Löschbrandt (sign.)

It can be seen from columns B and D how the pulp is irreparably impaired when the chips have been damaged previous to a strong chemical treatment.

supposed to pass from the bottom of the first digester over a sealed wash filter into the top of the second without the pressure being relieved, and the double-cooked pulp was to be sluiced to a blow tank and on to a recovery filter. With a digester 5 feet in diameter by 20 feet, the plant was designed for an output of 8 tons per 24 hours. A satisfactory operation even of the first digester was never obtained. The intermediate wash filter and the second digester soon had to be bypassed while the work was concentrated on the mechanical operation of the first digester. No means was found, however, of controlling the tendency of a liquor always to drain toward the outlet. On one hand this drainage depends on the pulp quality (slow or free stock), and on the other hand it affects the quality. These counter-actions resulted in uncontrollable oscillations of the liquor level and channelling of the pulp. Under these conditions stabilizing of the process proved to be impossible. No other solution seemed possible than to rebuild the plant (Fig. 2) to pass the chips from bottom to top of digester No. 1, using digester No. 2 merely as a kind of buffer. In this way, the problem of drainage was eliminated. Pulp and liquor were bound to pass the digester at a speed determined only by the feed, and gradually the plant was brought into regular operation from a mechanical point of view. But as far as the product was concerned, the whole operation proved a failure. Not a single test gave any hope of future improvements.

The high percentage of rejects could easily be explained. As the chips were fed directly into the impregnation vessel at full-digester temperature and pressure, the surface of the chips was overcooked while the heart (core) remained more or less uncooked resulting in a mixture with an average Roe number of 4 but obviously inferior to a corresponding normal pulp.

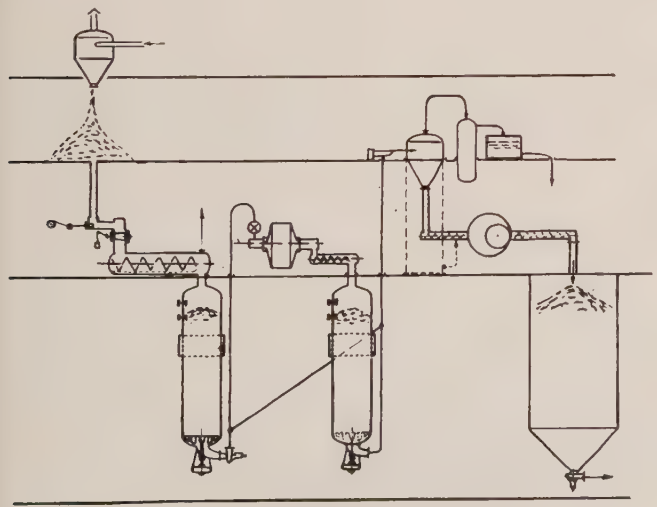

Fig. 1

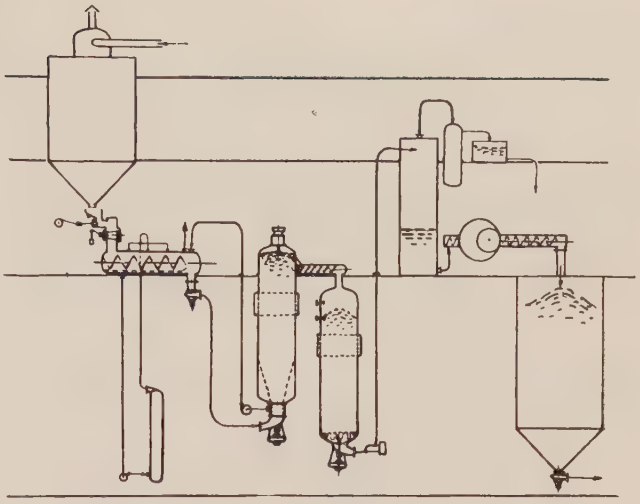

Fig. 2

But how to explain the extremely low strength factors, above all the double folding which varied from 0 to 150 (never exceeding 200) against 4000 to 6000 for normal kraft?

Chips picked immediately after the plunger showed no damage or deformation and it was not until the feeder plug was examined, that the conclusion was reached that as a result of the rough handling of the chips caused by the plunger feeder, the fiber was exposed to chemical attack and consequently destroyed.

To prove this a series of sulphite cooks under atmospheric conditions were made by the Central Laboratory in Oslo, by arrangement with a neighboring wallboard mill, on chips picked immediately before and after a plunger feeder as well as a screw feeder. Although it was scarcely possible to notice any visual difference between the different picks of chips, the tests showed that which was suspected as shown in Table I.

Chips were also picked after the plunger feeder in the pilot plant, placed in a cage, and cooked in the ordinary digesters of the mill. The resulting pulp was tested by the Central Laboratory in Stockholm, (Table II). As can be seen the trend is the same for sulphate as for sulphite, only slightly less accentuated. For comparison purposes a third column has been added showing the corresponding figures for normal pulp.

Table II.

Test cook A	*July 7, 1943*	*"Kalix Bleach"*	*"Royal Kalix Kraft"*
Revolutions	18,000	20,000	28,500
Freeness, S.R.	45	45	48
Tensile strength, m.	6,600	10,200	11,200
Burst	3.6	7.0	9.0
Tear	62	95	96
Double folds	125	5,500	4,216
Roe chlorine number	2.9	3.1	5.3

Method of analysis: Swedish standard
Refining: Lampén mill

These tests refer to chips which have passed the plunger feeding device under atmosphere conditions and then cooked in an ordinary digester, hung in a perforated container.

From the first column is seen how the quality has been completely destroyed as a result of the plunger feeding. The second and third columns give the figures of the mill's standard qualities.

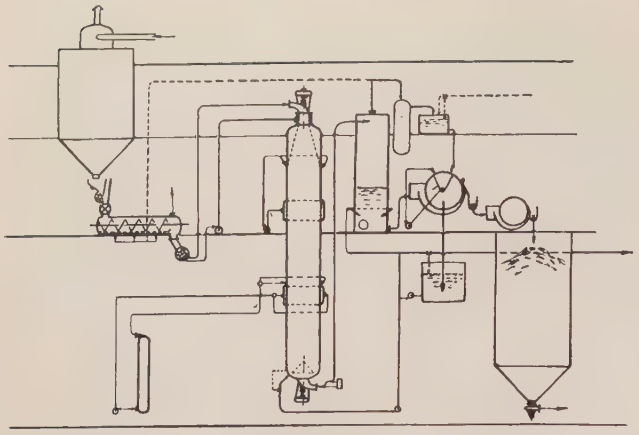

Fig. 3

As a result of these tests, the plunger feeder was replaced by two rotating valves of a type which was in operation in a couple of wallboard mills.. As was expected, the result improved very little as the mechanical effect of the bottom screw still was acting on the partially digested chips at full cooking temperature.

It was realized that the plant had either to be rebuilt with drastic changes or to be closed down with admitted defeat. During the past years, however, the ideas of continuous cooking had become more precise, and finally a completely new system was decided upon according to Fig. 3. The first digester was turned upside down and placed on top of the second one forming one digester of 5 feet diameter by 40 feet in which the contents moved downward by gravity. By means of compression liquor at the bottom, the digester was placed under a hydraulic pressure of about 30 p.s.i. higher than the steam pressure at 170°C., i.e., some 140 pounds, thereby preventing any formation of steam in the digester. By these means, 100°C. could be kept at the top, increasing to 170°C. further down, and these differences in temperature could be held as heat transmission was effectively checked. The classic cooking scheme was maintained:

1. Steaming of the chips with evacuation of air and gases.
2. Impregnation at 100 to 120°C. in the upper part of the digester.
3. Heating to digestion temperature of 165 to 170°C. in the central part.
4. Digestion during 1 to 2 hours in the lower part.
5. Blowing from the bottom.

The cooking liquor introduced at the top together with the chips had no chance of draining. Because of the black liquor introduced at the bottom to put the whole digester under hydraulic pressure, the first and most important stipulation was realized. Chips and liquor moved downward at the fixed rate of feeding and reached the bottom together, the chips being digested and the liquor exhausted.

The sluicing-out device was adjusted so as to have a somewhat higher capacity than the feeder governing the amount of chips and liquor at the top, the gap being filled automatically by the compression liquor introduced at the bottom. This arrangement brought about an elasticity of the system very much simplifying the operation.

The vessel which was previously used for impregnation with liquor now served for steaming of the chips to evacuate air and gases. The steaming vessel was kept under a pressure of some 10 pounds by means of rotating feed valves.

The problem of feeding against the full cooking pressure of 140 pounds without damaging the chips was accomplished by means of a rotating feeder, and a liquor circulation system was connected to a strainer on top of the digester. Two years were needed to develop this important part of the system into working condition and another year to eliminate the last deficiencies. From the operators point of view, this new feeding system offers an absolute security which is not the case with plunger or screw feeders with their risk of back-firing. As far as a defibrator is concerned, this risk does not mean so much. With a whole digester behind, however, a back-firing may cause a disaster. The new rotating feeders simply act as a shut-off valve in the case of a standstill. The design of the new feeders was a task which brought many problems. The low-pressure feeder which introduced the chips into the steaming vessel was simple enough. Quite another problem was involved in connection with the high-pressure feeder to the digester. The original design of this feeder showed a rotor exposed to the full digester pressure on one side only which resulted in a strong side thrust on the rotor. In spite of very heavy journals and bearings placed as close as possible to the rotor, the deflection and consequent wear could not be eliminated.

THE BALANCED ROTATING FEEDER

Figure 4 shows a type of feeder which is perfectly balanced as it has a pocket going diametrically through the rotor and provided with a screen in the middle. Though sand, rust, and other impurities necessarily are passed together with the chips, practically no wear has occurred. This is mainly because of the sealing and lubricating effect of insignificant leakages around the rotor.

This design of a balanced rotor brought further advantages which had not originally been considered, for instance, the possibility of feeding dry straw at a rate corresponding to 50% of the capacity performed with chips. The straw is washed into the pocket by means of circulating liquor, the liquor passing through, leaving the straw (or other material) on the screen to be washed out and onto the digester top as the pocket reaches the horizontal position.

In order to increase the capacity and maintain an almost regular flow of liquor, the rotor may be equipped with two, three, or more pockets, one adjacent to the other but at different angles, permitting an uninterrupted flow of liquor transporting the chips to the top of the digester.

HEATING

The problem of heating was solved by means of a strainer girdle in two separate halves and a pump circulating the liquor horizontally across the digester. After a few minutes the circulation has to be reversed to distribute the temperature more regularly, and to free the fibers adhering to the strainer in order to obtain a regular downward movement of the pulp. At the same time, the slots of the strainer will be auto-

matically cleaned. As a matter of fact, the strainer has, up to this time, not had to be cleaned once.

STRENGTH FIGURES

The second column of Table III shows the results obtained with the new system in February 1944, marking a considerable progress as compared to the results of a year earlier, indicated in the first column. As will be seen from the third column, the pulp actually produced today is of the very best quality.

Table IV gives the figures, in the first and second columns, for a strong and a medium pulp produced in

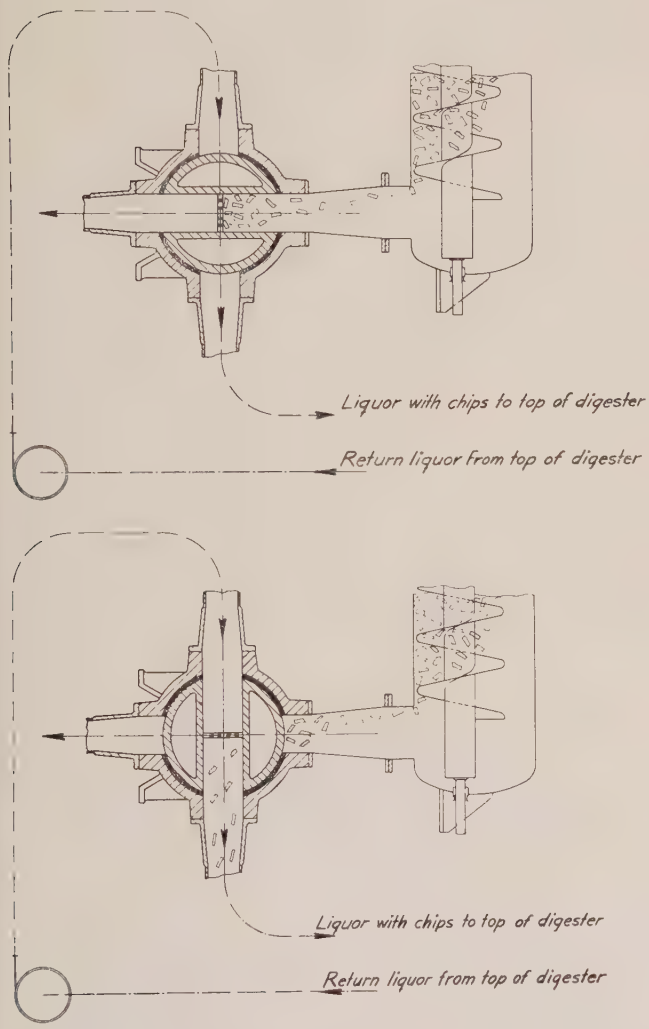
Liquor with chips to top of digester
Return liquor from top of digester
Liquor with chips to top of digester
Return liquor from top of digester

Fig. 4. Kamyr balanced feeder. On the left; when the pocket is in the vertical position, it is filled with chips by gravity. On the right; when the pocket is in the horizontal position, the chips are washed out and carried up to the top of the digester by means of circulating liquor

the continuous pilot plant. These figures compare favorably with ordinary kraft of high quality, as can be seen from the third column which gives the strength figures for the standard kraft of the main mill.

ADVANTAGES OF CONTINUOUS COOKING COMPARED TO THE BATCH SYSTEM

Higher quality and reduced tailings because of efficient steaming and thorough impregnation of the chips, and more uniform quality as the pulp goes up on the washer only a few minutes after completion of the cook so that there can be an immediate adjustment of the process: (a) by regulation of temperature, (b) by adjustment of the quantity of cooking liquor, (c) by changing from one screen girdle to the one above or below in order to vary the length of the cook, and (d) by changing the speed of the chip feeder.

Lower steam consumption due to a low liquor to wood ratio (about 2.7) and because of perfect recovery of the blow steam which is returned for steaming of the chips. Total steam consumption is less than 2000 pounds of steam per ton of pulp.

Table III.

Test	*Tested at Cellulosaindustriens Centrallaboratorium* XP 2/23/43	XP 2/25/44	*Tested at Karlsborgsverken's laboratory,* XP 2/24/48
Revolutions	18,000	14,000	28,500
Freshness, S.R.	43	45	47
Tensile strength, m.	5,100	9,950	11,300
Burst	2.3	6.7	9 8
Tear	38	83	93
Double folds	8	3,200	5,531
Roe chlorine number	3.3	3.8	5.5

Method of analysis: Swedish standard
Refining: Lampén mill

From the first column is seen an average result from the pilot plant according to Fig. 2. From the second column is seen how quality was improved in the new system according to Fig. 3. The third column shows the quality actually turned out in the pilot plant.

The blow tank is reduced to only a fraction of the size of the digesters, and the recovery of the liquor and washing of the pulp takes place a few minutes after completion of the cook.

There is reduced corrosion because no air is allowed into the digester. Air left in the chips after the steaming will be released from the top of the digester to the steaming vessel.

Longer life and less maintenance result as no variations in pressure, temperature, liquor, and gases occur.

Table IV. Results of the Latest Physical Tests of XP-Pulp at Karlsborgsverkens Laboratory

Test	*XP 2/20/48*	*XP 2/24/48*	*"Royal Kalix Kraft"*
Roe chlorine number	6.9	5.5	5.3
Revolutions	29,500	28,500	28,500
Freeness, S.R.	51	47	48
Tensile strength, m.	11,300	11,300	11,200
Burst, Kg./cm.^{2}	9.4	9.8	9.0
Tear	94	98	96
Double folds	4,278	5,531	4,216

Method of analysis: Swedish standard
Refining: Lampén mill

The first and second columns give the strength figures of a strong and a medium pulp from the continuous digester, comparing favorably with the standard kraft of the mill, see the third column.

Yield of pulp per 1000 cubic feet of digester volume may be considerably increased. According to Scandinavian practice a batch digester will produce about 10 tons per 24 hours per 1000 cubic feet. Under same conditions a continuous digester will make 15 to 20 tons per 24 hours per 1000 cubic feet. With the more forced cooking cycle of many kraft mills in the United States, this figure may be increased to 25 to 30 tons per 24 hours per 1000 cubic feet of digester volume, and still give a uniform pulp and high yield because of the efficient steaming and thorough impregnation of the chips.

The cost of installation compares very favorably, and the volume of buildings is reduced to a third.

Power and steam consumption is constant which is especially important to smaller mills and mills connected to local power stations that limit peak loads.

Automatic operation and control by means of instruments is easy in connection with a continuous digester.

The suppression of odor is more efficient owing to a constant and regular blowing.

On the whole, it is believed that while the continuous digester will meet with opposition, it will be accepted for the same reasons that continuous bleaching practically eliminated the batch bleachers.

MAINTENANCE

At first sight, increased maintenance might seem to reduce the advantages outlined above as admittedly there are quite a number of rotating parts in a continuous plant. The feeders, however, which are generally estimated to represent the most delicate part of the plant, have proved to be utterly reliable. Bolts and keys have been passed without trace of damage. The slotted strainers have been working for years absolutely without supervision. They are self-cleaning because of the downward movement of the pulp in connection with the reversion of the circulation. Also the pumps have proved to be satisfactory as long as they are provided with means for efficient water cooling of the stuffboxes in a manner similar to the current pumps for heating of batch digesters. On the whole it can be said that the exclusion of all manual operations leaves more time to be used for thorough supervision and maintenance.

OTHER APPLICATIONS

Continuous Sulphite Cooking

So far, Kamyr has concentrated on the continuous cooking of kraft pulp and similar processes such as soda or monosulphite. However, a pilot plant for sulphite cooking, based mainly on the same equipment as for kraft with a stainless steel digester $2^1/_2$ feet diameter by 27 feet in height, is under erection in a Swedish mill.

Certain difficulties are expected with sulphite in addition to the ones encountered with sulphate—on the other hand, greater advantages from a chemical point of view should be gained.

Prehydrolysis

Figure 5 shows a pilot plant being installed in France for pretreatment of chestnut for continuous extraction of tannins, with a digester $3^1/_2$ feet in diameter by 27 feet in height, made of acidproof steel. It is intended to apply the same principle for the prehydrolysis of chips by using sulphuric acid or SO_2, the chips passing upward through the digester and the washwater downward in counterflow in order to obtain a concentrated extract.

Bamboo Cooking

In a project for continuous cooking of bamboo in two stages, the black liquor recovered from the sulphate cooking in the second digester is passed in counterflow to the chips in the first digester, carrying away part of the incrustations and impurities to give a brighter and more easy bleaching pulp.

Continuous Digesters Under Construction

The first 30-ton per 24 hour unit is under erection in a Swedish mill, and it is expected to be in operation in the fall 1949. This first unit was ordered after paper had been manufactured in large scale with pulp produced in the pilot plant. Two more 30-ton units for hardwood are under construction in France. These are equipped so as to be able to produce 45 tons of semichemical pulp, and even 25 tons of straw pulp. (The reduced capacity on straw is not due to the digester but to the feeders and the bulk of straw.) One 60-ton unit is under construction in Italy for the production of ordinary kraft. One 80-ton unit is being projected for Sweden. Work is continuing with studies of a 150-ton unit.

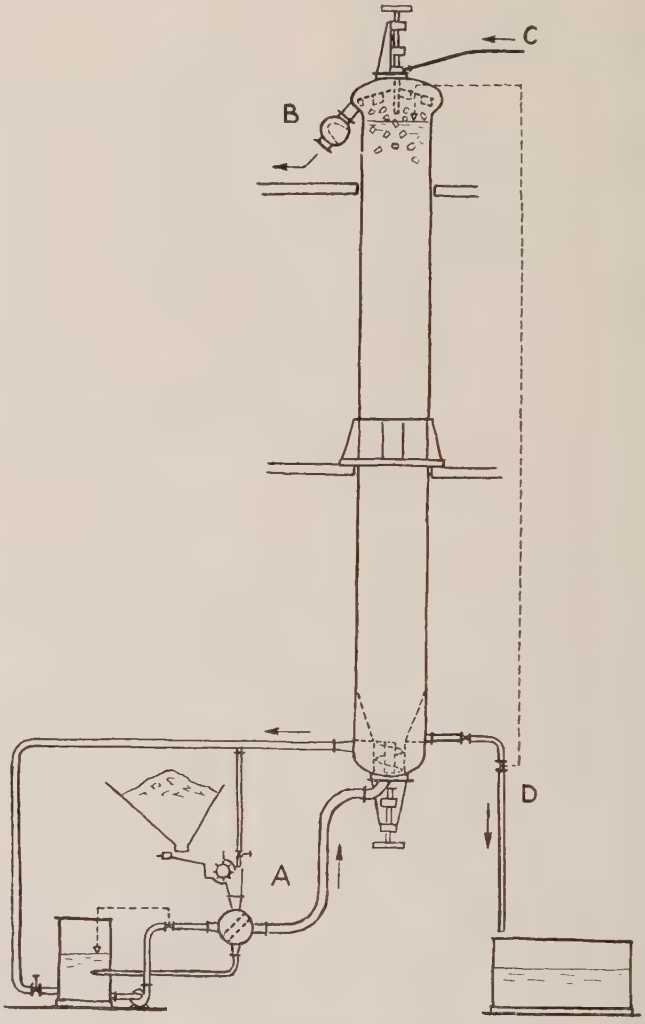

Fig. 5. Chips are introduced at the bottom A and sluiced out on top B. Washwater is introduced at the top C, flows downwards in counter-current to the chips and is extracted close to the bottom D

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Paper Partition Chromatography of Simple Sugars

As Applied to Pulp Hydrolyzates and to Other Related Substances

LOUIS E. WISE, JOHN W. GREEN, AND RUTH C. RITTENHOUSE

Paper partition chromatography was applied to the qualitative separation of simple sugars obtained from various polysaccharidic papermaking materials, such as partially hydrolyzed aspen and sprucewood, holocelluloses, soda, kraft, and sulphite pulp, and α-cellulose from black spruce, and such beater additives as guar, *Iles mannane*, and other related substances. The application and limitations of the method are discussed briefly.

In 1944, Consden, Gordon, and Martin (*1*) developed a partition method of chromatography in which filter paper strips were used as the stationary phase instead of a packed column. These investigators were successful in separating various α-amino acids from each other. In 1946–1948, Partridge (*2*) applied this method to the chromatographic separation of the sugars, in which over 20 sugars and sugar derivatives in aqueous solution were carefully studied using various immiscible organic developing solvents and, qualitatively, applying the technique to hydrolyzates of biological material (such as the specific polysaccharide of *Bacterium dysenterial* [Shiga]). Flood, Hirst, and Jones (*3*) extended this method to the quantitative estimation of certain of the simple sugars and recently they (*4*) have standardized and simplified their procedure, which was found applicable to the quantitative determination of sugars in such materials as almond tree, cherry, and cholla gums.

The qualitative use of paper partition chromatography has been found useful in showing the presence of specific sugars in complex mixtures, and in the hydrolyzates of such mucilages as guar, arabogalactan, various α-celluloses, and kraft, soda, and sulphite pulps. The results are of sufficient interest to warrant a brief report. The technique used was very similar to that described by Partridge.

Whatman No. 1 filter paper (the formation of which is satisfactory) was used as the stationary phase, the dimensions of the paper strips being 4 by 22 inches. The aqueous solutions usually contained 1% (weight/volume) of each of several sugars. From 0.5 to 1.0 mg. of a solution was introduced as a circular spot on a horizontal line ruled about 8 cm. from the top of the paper strip. When a number of different solutions were to be tested, spots were kept about 0.5 cm. apart (measuring from the circumference of each spot). A mixture consisting of butanol 40%, ethanol 10%, and water 50% (with or without 1% ammonium hydroxide) was prepared and, after removing the lower aqueous layer (*L*), the upper organic solvent layer was placed in a glass trough feeding the paper strip. The top edge of the strip carrying the sugars was then immersed in this solvent (about 4 cm. from the sugar spots) and the strip was allowed to hang vertically inside a closed vessel at the bottom of which was placed the aqueous layer (*L*) referred to above. The filter paper thus becomes rapidly saturated with vapor from phase (*L*). The temperature was maintained at 22 to 24°C. and the solvent was permitted to progress *downward* for about 16 to 20 hours (i.e., overnight). The lower solvent line was then marked off by a pencil line and the strip freed from solvent at 100°C. The solvent front usually advanced about 22 to 30 cm.

Depending on their configurations, the sugars migrate at different rates. After the solvent has been removed, the sugar spots are "fixed" by brushing evenly and swiftly (instead of spraying) with ammoniacal silver nitrate (0.1 *N* silver nitrate and 5 *N* ammonium hydroxide) and drying at 105°C. for 5 to 10 minutes. The relative positions of the sugars are shown by reddish-brown spots of metallic silver. The partition of the solute takes place between water bound by the paper and the solvent moving over its surface. The distance which any sugar moves is a function of (a) its coefficient of partition between water and the wet solvent, (b) the volume of water bound by unit area of filter paper, and (c) the volume of wet solvent held by unit area of the paper after irrigation. The two latter factors are substantially constant (assuming that the paper is uniform in structure, water content, and caliper). Under ideal conditions, the relative distance (termed R_F) that is traversed by each sugar is dependent only on its partition coefficient.

$$R_F = \frac{\text{distance on the strip moved by the sugar}}{\text{distance moved by the advancing front of organic solvent}}$$

In the experiments carried out at the Institute the R_F of a specific sugar was seldom determined. In its place, the sugar migrations were compared directly with known sugar solutions carried out on the same paper strip on which the unknown samples were chromatographed. For example, when a sample of hydrolyzed guar mucilage was subjected to partition chromatography, the results were compared directly with those given with pure galactose and pure mannose solutions (or mixtures of these). In general, satisfactory results (and discrete spots) were obtained with sugar mixtures containing as many as four sugars. Less satisfactory results were obtained when uronic acids were also present. Sugars which could be readily differentiated were glucose, mannose, xylose, and rhamnose. On the other hand, it was found very mannose and arabinose, and arabinose and fructose, mannose and arabinose, and arabinose and fructose, because their R_F values are nearly the same. Fructose

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may be differentiated from most common aldose sugars because this ketose gives, within a few minutes, a pale salmon-pink to brown spot with naphthoresorcinol-trichloroacetic acid developer, whereas the other sugars often remain unaffected for hours. After a certain time lag, however, this reagent gives a pale bluish stain with the pentoses and, under some conditions, even the aldehexoses give a slight coloration. Hence, the fructose color reaction, although suggestive, is never entirely conclusive.

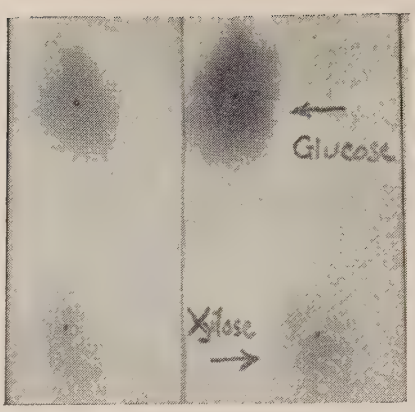
Glucose and galactose in admixture cannot be separated easily. If, however, *s*-collidine is used in place of the butanol solvent mixture, these two sugars can be distinguished quite readily. By the use of the usual butanol solvent, galactose can be easily differentiated from arabinose, fructose, mannose, xylose, or rhamnose.

It was interesting that, in the hydrolysis of a black spruce α-cellulose, mannose as well as glucose was present in the hydrolyzates. No xylose was found. A bleached kraft on hydrolysis gave largely glucose, and small amounts of xylose and mannose. A faint D-fructose spot with naphthoresorcinol was also noted but, as stated above, its presence is not proved. Fructose units had previously been found in sulphite pulp by Hägglund and Klingstedt (*5*) (who identified the sugar as the α-methylphenylhydrazone melting at 147 to 148°). A bleached soda pulp gave only glucose and xylose, and a bleached sulphite pulp from western hemlock gave dominantly glucose, possible traces of xylose, and no indications of mannose.

Hydrolyzates are best neutralized with barium carbonate, and barium sulphate is removed by filtration. Subsequently, any soluble barium salts (e.g., barium aldobionates) must be carefully removed from the filtrates. This can be done usually by evaporating the mixtures to a syrup, and precipitating the barium salts with a large excess of alcohol (until an aliquot of the filtrate gives no barium test when treated with a drop of dilute sulphuric acid). The filtered mixture is again evaporated to a syrup and then chromatographed.

The method is most advantageously employed when one sugar is not in too great an excess. For instance, in pulps in which glucose groups predominate (often to the extent of 90% of the total sugar units), it is essential to increase the size of the sample so that the other sugars will be of sufficiently high concentration to give characteristic spotted areas. This may result in a greatly exaggerated glucose spot, spread beyond its usual boundaries. A danger exists in contamination due to exceedingly small amounts of sugar (which may be picked up from external sources). Spot tests can be obtained with as little as one microgram of an individual sugar.

The chromatographic method has been used successfully in the following instances. The hydrolyzates of *Iles mannane* (a possible beater additive obtained from the East Indies) plainly showed the presence of mannose and glucose. The hydrolyzate of a polysaccharide extracted by Brauns (*6*) from black spruce was shown to consist principally of galactose and arabinose, with the former predominating. The hydrolysis products of guar mucilage (used as a beater additive) yielded only mannose and galactose when subjected to paper chromatography. The prehydrolyzates (with dilute acid) from aspen gave a distinct test only for xylose, whereas the prehydrolyzates from spruce yielded galactose, mannose, and xylose. On the other hand, a *complete* hydrolysis of sprucewood or its holocellulose yielded largely glucose, with much smaller amounts of xylose and mannose. Slash pinewood and its holocellulose gave products similar to those from spruce. Interestingly enough, the skinlike substance obtained as an insoluble residue by the treatment of coniferous pulp fibers with cuprammonium hydroxide (*7*) gave on hydrolysis predominantly mannose, together with smaller amounts of glucose. Inasmuch as the mannose spots are normally so close to the fructose and arabinose spots in a paper chromatogram, the presence of mannose was confirmed by the formation of mannose phenylhydrazone [melting at 186 to 188° (decompn.)]. Fructose was shown to be absent by the naphthoresorcinol-trichloroacetic acid test. The presence or absence of small amounts of arabinose remains an open question.



Hydrolyzed soda pulp (bleached) — Chromatograms of glucose and xylose

Fig. 1

In Fig. 1, the reproduction of part of a chromatogram from a known mixture of pure sugars is compared with one obtained from a kraft pulp hydrolyzate. The unidentified spots formed from the hydrolyzate in this figure may represent either unhydrolyzed material or "reversion" products formed from the sugars by the extended action of acids (control experiments with pure sugars showed this same effect).

The method is extremely rapid and is very useful in showing the presence (or absence) of dominant sugars in any hydrolyzate and in permitting the identification of very small amounts of most of the common sugars. Its limitations are also self evident.

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Received Feb. 14, 1949. Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, Hotel Commodore, New York, N. Y., Feb. 21–24, 1949.

UNITED STATES PATENTS ON PAPERMAKING

First Quarter, 1949 — *Compiled by CLARENCE J. WEST*

The following list of patents has been compiled from the current numbers of the Official Gazette of the United States Patent Office. Because, as a rule, only one claim is published in the Gazette, it is not claimed that the list is complete; also, it is possible that the list may contain some patents that do not apply specifically to pulp and paper manufacture.

Copies of any of the following patents can be obtained from the United States Patent Office, Washington 25, D. C., by sending twenty-five cents for each patent desired.

January 4, 1949

2,457,797. Process for the preparation of a pigment complex, including a reacted starch. William L. Craig, assignor to R. T. Vanderbilt Co., Inc., New York, N. Y. Filed June 16, 1945. 3 claims. (Cl. 106-306.) Aqueous solutions of calcium chloride react with starch to produce a complex from which improved carbonate and borate pigments can be prepared, suitable filling or coating agents for paper.

2,457,809. Envelope having tamper detection means. Donald L. Drummond, Santa Maria, Calif. Filed Aug. 23, 1945. 5 claims. (Cl. 229-883.) Perforations are made in the flaps of the envelope so that tears will occur if the envelope is tampered with. Indicator paper is attached to the flap which will discolor if steam is applied.

2,457,822. Milk container. John P. Jones, assignor to Dairy Specialties, Inc., Omaha, Nebr. Filed April 26, 1944. 4 claims. (Cl. 229-7.) A paper milk bottle is provided with a perforated partition at the lower cream level.

2,457,847. Tall oil-cellulose ether composition. Warren Stubblebine, assignor to Armstrong Cork Co., Lancaster, Pa. Filed July 31, 1943. 14 claims. (Cl. 260-17.) A mixture of tall oil and ethylcellulose or benzylcellulose is used with cumar resin or a chlorinated diphenyl.

2,458,173. Shopping bag handle. Emanuel S. Kardon, assignor to American Bag & Paper Corp., Philadelphia, Pa. Filed Dec. 18, 1945. (Cl. 229-54).

2,458,281. Bottle carrier. Elmer H. Lupton, Ilchester, Md., assignor to The Bartgis Bros. Co. Filed Oct. 20, 1944. 1 claim. (Cl. 229-52.) A cardboard bottle holder can be folded flat for storage and shipment.

2,458,341. Carton folding machine. Andrew R. Cake, Norfolk, Va. Filed Aug. 3, 1944. 19 claims. (Cl. 93-49.)

2,458,428. Coating composition for moistureproofing by hot melt coating. Martin Salo, assignor to Eastman Kodak Co., Rochester, N. Y. Filed Dec. 12, 1945. 5 claims. (Cl. 260-17.) The composition consists of 64–70% cellulose acetate butyrate, 13–23% di(2-ethylhexyl)phthalate, 10–18% polyvinyl acetate, and 1% paraffin wax.

January 11, 1949

2,458,578. Folding box. Guy J. Evans, Buffalo, N. Y. Filed May 31, 1946. 1 claim. (Cl. 229-41.) A folding box for cake or like commodity.

2,458,737. Shockproof bottle container. Mortimer B. Salkowitz, Brooklyn, N. Y. Filed Feb. 26, 1947. 3 claims. (Cl. 229-90.) A safety container for bottles or the like consists of a composite tubular liner sleeve including an outer and an inner tube of paper stock and an interspacer of corrugated board, together with two sheet metal end disks.

2,458,766. Combined bottle container and support. Raymond Chemlinski, Schenectady, N. Y. Filed Jan. 16, 1947. 1 claim. (Cl. 206-45.14.) A rectangular container is so constructed that a portion of the top wall may be raised to insert a bottle.

2,458,834. Container. Archie J. Chateauneuf, Lockport, N. Y. Filed April 9, 1946. 2 claims. (Cl. 229-23.) Ornamental display boxes are composed of a plurality of sections connected with strips of flexible material.

2,458,844. Packaging. James Foote, assignor to B.F.D. Co., New York. N. Y. Filed Jan. 5, 1946. 18 claims. (Cl. 206-58.) A carton for dispensing wax paper in rolls.

2,458,883. Box and package handle. William Trogman, Chicago, Ill. Filed Nov. 13, 1944. 1 claim. (Cl. 16-125.) A one-piece handle having a finger guard is constructed from a single sheet of material.

2,458,953. Apparatus and method for determining the scuff resistance of leather. Charles W. Mann, assignor to the United States of America (Secretary of Agriculture). Filed Feb. 24, 1947. 10 claims. (Cl. 73-7.) The principle of the apparatus might be applied to the testing of paper.

2,458,972. Method of making a bag having a filler mouthpiece in one end. Howard A. Wolf, assignor to Wolf Brothers, Philadelphia, Pa. Filed Dec. 1, 1945. 1 claim. (Cl. 93-35.) A method is proposed for securing a mouthpiece in one end of a paper or fabric bag adapted to be used with a vacuum cleaner.

2,459,073. Paper cup having a pouring lip extending outwardly from side wall. Kenneth C. Hamilton, assignor to Milwaukee Lace Paper Co., Milwaukee, Wis. Filed Nov. 4, 1944. 6 claims. (Cl. 229-4.5.) The cup is so formed as to provide a plurality of thicknesses of material in the portion of the cup side wall forming the lip.

2,459,130. Cream dispenser. John P. Jones, assignor to The Dairy Specialties Co., Inco, Omaha, Nebr. Filed Jan. 12, 1946. 6 claims. (Cl. 229-7.) The waxed paper-type of milk and cream containers is provided with a cream dispenser in the overlapping portions.

January 18, 1949

2,459,180. Apparatus for charging fibrous material into a digester, Johan C. F. C. Richter, assignor to Aktiebolaget Kamyr, Karlstadt, Sweden. Filed July 30, 1945. 8 claims. (Cl. 214-17.) An apparatus is described for charging a fibrous material into the liquid-filled space of a digester under pressure.

2,459,266. Article for reproducing drawings on blanks. George B. Crouse, assignor to Photo-Positive Corp., New York, N. Y. Filed Aug. 30, 1944. 4 claims. (Cl. 95-8.) A light-sensitive sheet for reproducing drawings on a template or the like.

2,459,364. Creped paper and method of making. Robert F. Charles and Frank W. Durgin, assignors to Dennison Co., Framingham, Mass. Filed Dec. 5, 1944. 8 claims. (Cl. 154-33.05.) Paper is impregnated with an aqueous solution of a polymerizable synthetic resin, creped to produce a high ratio crepe above 1.5:1, and heated to polymerize the resin.

2,459,565. Display box. William R. Lee, San Mateo, Calif. Filed April 10, 1946. 1 claim. (Cl. 206-45.19.) A display filler adapted to be placed within a box.

2,459,570. Method of refining sulfate turpentine. George H. McGregor, assignor to Minnesota and Ontario Paper Co., Minneapolis, Minn. Filed June 27, 1947. 5 claims. (Cl. 92-2.) The odor of sulfate turpentine is removed by extracting the turpentine at 80–100°F. with kraft green liquor and then shaking it with calcium hypochlorite.

2,459,622. Method of and apparatus for drying sheet materials by high-frequency electric fields. Wallace P. Cohoe and Mitchell Wilson, assignors to Fred'k H. Levey Co., Inc., New York, N. Y. Filed March 18, 1944. 15 claims. (Cl. 219-47.) Coated paper, printed paper webs, and the like can be dried in a high-frequency electric field.

2,459,623. Method and apparatus for drying sheet materials. Wallace P. Cohoe and Max R. Saslaw, assignors to Fred'k H. Levey Co., Inc., New York, N. Y. Filed May 5, 1945. 14 claims. (Cl. 219-47.) Paper and the like are subjected to an electric field to remove water and organic solvents.

2,459,645 Folded-blank box tray. Claude H. Hensley, assignor to Gaylord Container Corp., St. Louis, Mo. Filed July 5, 1946. 2 claims. (Cl. 229-34.) Folded-blank box trays in which two of the sides have corner flaps folded inward and secured by folding over upper marginal flaps of the other two sides.

2,459,678. Carton opener. Samuel H. Berch, assignor to Arden Farms Co., Los Angeles, Calif. Filed Feb. 7, 1947. 11 claims. (Cl. 93-2.) The machine is designed for opening containers holding ice cream.

2,459,727. Bulk ice-cream container. Hubert B. Tillery, Kansas City, Mo. Filed March 7, 1946. 2 claims. (Cl. 229-6.) An octagonal container has a removable or piston-like bottom for removal of the contents.

(*continued on page 46 A*)

CLARENCE J. WEST, Chairman, Committee on Bibliography, TAPPI.

(*continued from page 45 A*)

2,459,728. Bulk ice-cream container. Hubert B. Tillery, Kansas City, Mo. Filed March 7, 1946. 2 claims. (Cl. 229-16.) The container is composed of two parts, the side walls and bottom retainer and the bottom, the latter being used as a piston.

January 25, 1949

2,459,851. Ligno-cellulose die-stock and process of making. Charles F. Story, assignor to Masonite Corporation, Laurel, Miss. Filed Dec. 31, 1941. 2 claims. (Cl. 154-132.) A method of making thick dense slabs having high-bond strength and a low percentage of water-soluble material from steam-treated and exploded lignocellulosic material by bonding relatively thin boards with an adhesive.

2,459,939. Container. Irving Hill and Justin D. Hill, assignors to The Lawrence Paper Co., Lawrence, Kans. Filed July 8, 1946. 2 claims. (Cl. 229-36.) Containers of the knockdown type suitable for shipping eggs, fruits, vegetables, and the like.

2,460,020. Egg crate. Elmer H. Lupton, Ilchester, Md., assignor to The Bartgis Bros. Co. Filed Jan. 8, 1945. 3 claims. (Cl. 229-29.) An egg crate structure, box, partitions, and barriers are formed from a single blank and kept in a single homogeneous sheet before bending.

2,460,042. Method of making cockle paper. Stephen B. Stafford, assignor to Rice Barton Corp., Worcester, Mass. Filed Jan. 13, 1945. 2 claims. (Cl. 117-11.) Paper is impregnated with a suitable animal or vegetable sizing material and dried in a horizontal position by suitably applied heat, being moved forward under a controlled light tension.

2,460,108. Collapsible carrier. Richard E. Smith and Paul A. Musso, assignors to C. Schmidt & Sons, Inc., Philadelphia, Pa. Filed Aug. 31, 1946. 1 claim. (Cl. 229-28.) A single blank for forming a collapsible bottle carrier.

2,460,129. Apparatus for manufacture of fibrous articles. Paul E. Ista, assignor to General Electric Co., Schenectady, N. Y. Filed Aug. 10, 1946. 2 claims. (Cl. 92-54.) A method of molding pulp articles which have different physical properties in different portions of the article.

2,460,229. Bottle holder. Samuel N. Lebold, assignor to Morris Paper Mills, Chicago, Ill. Filed Sept. 27, 1947. 4 claims. (Cl. 229-52.) This is a continuation of U. S. patent 2,389,318 (Nov. 20, 1945) and relates to a method of construction of a bottle carrier and holder from comparatively lightweight paperboard.

February 1, 1949

2,460,278. Rotary pump for thick fibrous suspensions. Ernest P. Cook, assignor to Improved Paper Machinery Corp., Nashua, N. H. Filed Feb. 4, 1944. 36 claims. (Cl. 103-126.)

2,460,282. Regenerated cellulose dielectric material and process of producing the same. Guy B. Cardner, assignor to Aerovox Corp., New Bedford, Mass. Filed July 22, 1941. 7 claims. (Cl. 18-48.) A method is decribed of washing cellophane to form a dielectric material.

2,460,353. Shingle. Joseph L. Killingsworth, Des Moines, Iowa. Filed May 9, 1946. 5 claims. (Cl. 108-7.) An interlocking shingle of substantially T shape.

2,460,485. Flexible wrinkle coated material and method of producing same. Nathan T. Beynon, assignor to New Wrinkle, Inc., Wilmington, Del. Filed May 21, 1948. 11 claims. (Cl. 117-41.) The coating composition may consist of 100 parts by weight of an unsaturated fatty oil containing conjugated double bonds, 40 parts of polyvinyl chloride, 60 parts of pigment paste, and 10 parts of naphtha.

2,460,627. Process for the isolation of soybean protein. Eero O. Erkko and Richard T. Trelfa, assignors to Hercules Powder Co., Wilmington, Del. Filed Sept. 7, 1946. 7 claims. (Cl. 260-112.)

2,460,655. Apparatus for determining the permeability of materials. Ernest W. Rickmeyer, assignor to Jefferson Electric Co., Bellwood, Ill. Filed Nov. 16, 1945. 3 claims. (Cl. 73-38.)

2,460,691. Web tensioning and pressure mechanism. Henry L. Haswell, assignor to Ecusta Paper Corp., Pisgah Forest, N. C. Filed Aug. 8, 1945. 16 claims. (Cl. 242-75.) A mechanism for a slitting and rewinding machine regulates the tension on the web from the supply roll and controls the operation of the rewind roll.

2,460,734. Asbestos impregnated with tin oxide and process of producing. Thomas D. Callinan, assignor to General Electric Company, Schenectady, N. Y. Filed Oct. 4, 1944. 2 claims. (Cl. 117-126.) Asbestos paper consisting 70–80 parts asbestos and 20–30 parts clay is impregnated with an aqueous solution of alpha stannic oxide and heated at 60–100°C.

2,460,787. Felt base material for adhesive attachment to surfaces and coating composition for same. Ralph F. Seedorf, assignor to Carthage Mills, Inc., Cincinnati, Ohio. Filed April 30, 1945. 9 claims. (Cl. 117-90.) A coating composition for felt base materials saturated with asphalt contains rosin size or rosin and tall oil; the coated product can be cemented to wallboard, plasterboard, and the like.

February 8, 1949

2,460,820. Method of making containers. Vahan Hagopian, New York, N. Y. Filed March 18, 1944. 6 claims. (Cl. 93-36.) Cup-shaped plies of paper or the like are formed by conventional procedures and coated or impregnated with a thermoresponsive adhesive; two or more plies are nested to form a laminar set and bonded by pressure applied through an inflatable bag.

2,460,870. Box. William K. Bruckhauser, assignor to International Paper Co., New York, N. Y. Filed Nov. 13, 1945. 3 claims. (Cl. 229-23.) A paperboard box of corrugated board has a reinforced structure in which the end walls are adapted to receive and securely hold end portions of a removable lid; it is suitable for packaging tomatoes and the like.

2,460,885. Multiply pasted end bag with sealed inner ply. Edgar B. Hoppe, assignor to St. Regis Paper Co., New York, N. Y. Filed Dec. 9, 1944. 2 claims. (Cl. 229-59.) A multiply pasted-end bag is provided with a sealed inner ply which prevents the contents of the bag from contacting any portion of any ply except the inner ply.

2,460,886. Multiply pasted end bag. Edgar B. Hoppe, assignor to St. Regis Paper Co., New York, N. Y. Filed Dec. 3, 1946. 2 claims. (Cl. 229-59.) This is a division of the above patent. The bag has a pasted end closure of high strength, wherein each ply is secured independently of and without necessarily relying on the strength of the other plies.

2,460,892. Box shaping machine. Wade H. Lisle, assigned to Crook Paper Box Co., North Kansas City, Mo. Filed Oct. 14, 1946. 2 claims. (Cl. 93-53.) A box-shaping machine has a mechanism for flexing the side walls of the box as it is advanced in such a manner as to exert an additional inward bend to the box at the lines of fold.

2,460,909. Bellows type envelope having all edges of mouth reinforced. Morton J. Shaffer, New York, N. Y. Filed March 8, 1946. 1 claim. (Cl. 229-68.) An expansible envelope of the bellow type suitable for filing purposes.

2,460,947. Process for the production of yeast. Sven O. Rosenqvist, Rotebro, Sweden, assignor to Svenska Jästfabriks Aktiebolaget. Filed Jan. 23, 1946. 6 claims. (Cl. 195-91.) *Torula utilis* is grown on a mixture of molasses wort and the still residue from fermented sulphite waste liquor. The protein compounds of the molasses have a favorable effect on the color of the resulting yeast.

2,460,998. Method of coating paper. Harley E. Nelson, assignor to Stein, Hall & Co., Inc., Chicago, Ill. Filed March 20, 1944. 3 claims. (Cl. 117-76.) Paper is coated with an acid-deflocculated clay and a starchy polysaccharide film-forming binder, dried, and treated with a resinous condensation product (urea- or melamine-formaldehyde resin), with a subsequent heating to insolubilize the resultant coating.

2,461,105. Bleaching of cellulosic matter. Rudolf Bloch, Kurt Goldschmid, Isaac Schnerb, and Paul Goldschmidt. Filed Dec. 17, 1946. 10 claims. (Cl. 8-105.) The hypochlorite bleaching of pulp is carried out in the presence of bromine ion; this accelerates the bleaching operation and a lower concentration of hypochlorite can be employed.

2,461,109. Manufacture of paper. Kay Crabtree, Crabtree Mills, Quebec, Canada. Filed Sept. 30, 1944. 1 claim. (Cl. 92-68.) A method of seasoning paper to eliminate curl and wavy characteristics.

2,461,209. Waterproof shipping container. Harold J. Grampp, assignor to Hercules Powder Co., Wilmington, Del. Filed Dec. 10, 1946. 18 claims. (Cl. 229-5.5) A container for explosive cartridges is claimed.

2,461,246. Web severing method and apparatus. John T. Weyenberg, assignor to Paper Patents Co., Neenah, Wis. Filed Aug. 21, 1944. 6 claims. (Cl. 242-56.) A method of severing a web which is being delivered to and wound upon a reel and of starting the winding of the severed leading end of the web.

2,461,251. Container. Charles O. Ball and Franklin D. Scott, assignors to Owens-Illinois Glass Co., Toledo, Ohio. Filed March 12, 1945. 4 claims. (Cl. 229-37.) A milk container.

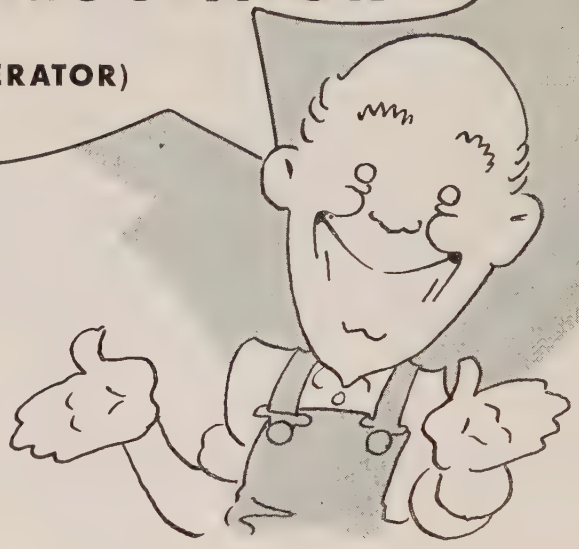
2,461,302. Method of flameproofing. John Truhlar and Athan A. Pantsios, assignors to Rudolf F. Hlavaty, Cicero, Ill. Filed July 28, 1945. 1 claim. (Cl. 117-138.) The fireproofing agent is a solution of 80 parts acetone, 20 parts antimony trichloride, and 8 parts triamyl phosphite; the saturated material is steamed for 3–5 minutes, exposed to the vapors of ammonia, and dried.

2,461,310. Apparatus for measuring humidity. Putnam Cilley, assignor to The Foxboro Co., Foxboro, Mass. Filed May 21, 1947. 5 claims. (Cl. 73-335.) The apparatus con-

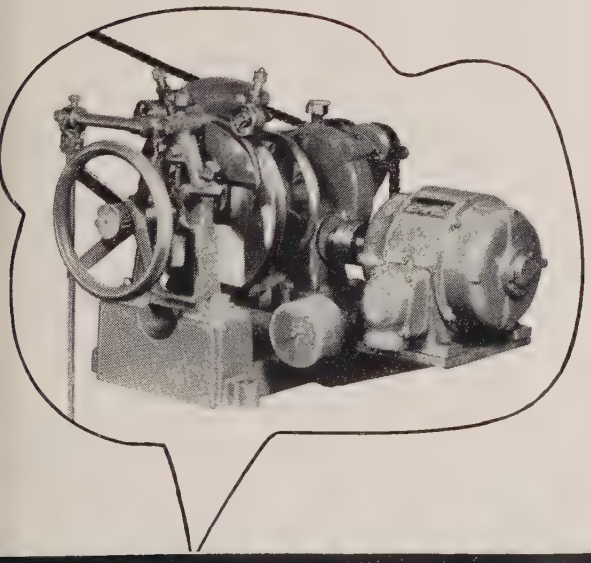
(*continued on page 48 A*)

"WHEN I LOOK BACK, I WONDER HOW WE EVER MADE ACCEPTABLE PAPER WITHOUT THE BIRD CONSISTENCY REGULATOR"

(SAYS THE OPERATOR)



The mill is making board specialties and the Bird Regulator is installed at the machine chest. They give it credit for a substantial production increase and they now feel they couldn't make satisfactory paper without it.



Bird Consistency Regulators are being put in all over the place — ahead of knotters and flat screens in pulp mills, at pulp thickeners before bleaching, at pulp drying machines and ahead of brown stock washers; in paper mills at the Jordans and at stuff chests and machine chests, after plunger pumps and centrifugal pumps.

The Bird Regulator holds consistency to not more than 0.1% heavier or lighter than desired. It works steadily and dependably, without attention.

May we submit layouts and estimates?

BIRD MACHINE COMPANY

SOUTH WALPOLE • MASSACHUSETTS

(*continued from page 46 A*)

sists of a sheet of paper, an electrical resistance element bonded to the paper, and an electrical resistance measuring circuit.

2,461,376. Sheet stretching mechanism. Frank Feldmeier, assignor to Blaw-Knox Co., Pittsburgh, Pa. Filed May 28, 1947. 3 claims. (Cl. 271-52.) A mechanism is described for gripping sheet material at its lateral edges while supported on a moving surface to stretch the sheet material and maintain it in a flat position.

2,461,388. Gluing machine. Robert Minkow, assignor to Minco Products Corp., New York, N. Y. Filed May 21, 1945. 1 claim. (Cl.91-51.) The invention covers an improved table construction which can be moved to an inoperative position for filling and for cleaning the glue or doctor roller.

February 15, 1949

2,461,538. Fire-retarding compositions. Earl K. Fischer, assignor to Interchemical Corp., New York, N. Y. Filed May 25, 1944. 3 claims. (Cl. 260-28.) The fireproofing agent is selected from the chlorinated paraffins, chlorinated naphthalene, or chlorinated diphenyl and is mixed with from 5 to 50% of the reaction product of an aldehyde and urea, thiourea, melamine, and the like.

2,461,581. Container and method of manufacture. Allen B. Wilson, assignor of one half each to Kimberly Stuart and Elizabeth R. B. Stuart, Menasha, Wis. Filed Dec. 23, 1944. 5 claims. (Cl. 229-5.5.) A paper or fiber shipping drum or container is reinforced at each end with metal rims or beads.

2,461,618. Folding box. Alvin Whittager, Burbank, Calif. Filed Oct. 9, 1945. 1 claim. (Cl. 229-52.) A folding box is described for packaging dresses and the like which has a metallic or plastic handle.

2,461,704. Adhesive and coating composition. Fred B. Speyer, assignor to Shellmar Products Corp., Mount Vernon, Ohio. Filed Nov. 23, 1945. 1 claim. (Cl. 260-736.) A pressure-sensitive greaseproof adhesive contains polymerized linseed oil, chlorinated rubber, microcrystalline wax, ethyl acetate, and toluene.

2,461,924. Impact type log peeler. Charles J. Robertson, Hattiedsburg, Miss. Filed Nov. 27, 1945. 4 claims. (Cl. 144-208.) The log is subjected to a whipping action produced by rotary flexible members.

2,462,029. Adhesive compositions. Lloyd M. Perry, assignor to Nashua Gummed and Coated Paper Co., Nashua, N. H. Filed May 25, 1945. 7 claims. (Cl. 260-29.1.) The adhesive contains 45 parts indene resin, 10 parts ethylcellulose, and 45 parts diphenyl phthalate.

2,462,037. Sealing and reinforcing tape. Lewis Davis and Edwin C. Tuukkanen, assignors to McLaurin-Jones Co., Brookfield, Mass. Filed Jan. 11, 1943. 3 claims. (Cl. 117-122.) The adhesive consists of 4 parts ethylcellulose, 7 parts Staybelite, and 2 parts Hercolyn.

February 22, 1949

2,462,297. Apparatus for saturating fabrics. Floyd W. Adams, assignor to Los Angeles Paper Box Factory, Los Angeles, Calif. Filed April 9, 1945. 5 claims. (Cl. 91-18.) An apparatus is described for saturating or impregnating dry felt for use as a roofing material.

2,462,312. Shot shell. Walter L. Finlay and Gilbert E. Hutchinson, assignors to Remington Arms Co., Inc., Bridgeport, Conn. Filed Aug. 2, 1944. 4 claims. (Cl. 102-42.) The patent covers a filler wad column for a shot shell.

2,462,460. Carton closing machine. Joseph W. Binsack, assignor to Beech-Nut Packing Co., Canajoharie, N. Y. Filed Dec. 8, 1945. 5 claims. (Cl. 93-2.)

2,462,497. Ice-cream cup. Albert A. Heyman, assignor to Maryland Baking Company, Inc., Baltimore, Md. Filed Jan. 29, 1948. 2 claims. (Cl. 99-89.)

2,462,513. Box folding machine and method. Walter H, Kucklinsky, Paramus, N. J. Filed Sept. 26, 1947. 17 claims. (Cl. 93-49.) A method and machine are described for effecting folds in blanks of thin materials, the folds being along lines at substantial angles to the path of travel of the blanks.

2,462,558. Tension control means for running webs. Joseph S. Scheuermann and Thomas N. Carter, assignors to Cameron Machine Co., Brooklyn, N. Y. Filed June 15, 1944. 4 claims. (Cl. 242-75.) A method for accurately and quickly controlling the tension of a web of a paper when it is unwound from one roll, passes through a processing machine, and is rewound into a second roll.

2,462,631. Coating composition. Lewis D. Gittings and Robert H. Fundaburk, assignors to Monsanto Chemical Co., St. Louis, Mo. Filed March 13, 1944. 14 claims. (Cl. 106-239.) Rosin is plasticized with biphenyl, *o*-terphenyl, or *m*-terphenyl.

2,462,676. Bottle carton. Melvin A. Riley and Donald C. McClelland, assignors to The Baltimore Paper Box Co., Baltimore, Md. Filed April 16, 1946. 6 claims. (Cl. 229-52.) A bottle carrier is so constructed that it can be shipped with the top of the carton in a flat condition.

2,462,803. Fireproofing composition. Kenneth S. Campbell and Jack E. Sands, assignors to the United States of America (Secretary of Agriculture). Filed March 23, 1945. 9 claims. (Cl. 260-28.) The composition contains a chlorinated paraffin wax, a water-soluble urea-formaldehyde condensation product, and antimony oxide.

March 1, 1949

2,462,990. Shingle. Ernest R. Nolan, Wheatridge, and Edward W. Danbom, Denver, Colo. Filed Aug. 2, 1946. 4 claims. (Cl. 108-8.) The shingle is made from Celotex which is covered on one side and three edges with aluminum or an aluminum alloy.

2,463,000. Process for the production of furfural. John W. Sevón, Kuusankoski, Finland. Filed April 12, 1946. 4 claims. (Cl. 260-347.) Fermented sulphite waste liquor, freed from alcohol by distillation, is acidified, heated in an autoclave at 150–180°C., and distilled to recover the furfural.

2,463,084. Revolving high-velocity jet for hollow-head-type barker having low-pressure water supply. Harry E. Bukowsky, assignor to Crown Zellerbach Corp., San Francisco, Calif. Filed Feb. 6, 1945. 9 claims. (Cl. 144-208.) The water is delivered to the barker at low pressure and the necessary hydraulic jet velocity is developed in the machine itself.

2,463,148. Waterproof adhesive and bonding process. George V. Caesar, Jordan V. Bauer, and Don M. Hawley, assignors to Stein, Hall & Co., Inc., Chicago, Ill. Filed June 17, 1943. 2 claims. (Cl. 260-17.3.) The adhesive contains 15–85% by weight of total solids of ungelatinized starch, 5–50% of urea-formaldehyde condensation product, 5–75% of gelatinized starch, and a ratio of water to solids within the range of 4:1 to 1:1.

2,463,208. Paper currency disinfector. Joseph J. Schutten, North Redondo, Calif. Filed Aug. 5, 1947. 5 claims. (Cl. 21-76.) A disinfectant is applied to both sides of paper currency by means of a perforated roller.

2,463,241. Apparatus for the manufacture of abrasives. Richard P. Carlton, assignor to Behr-Manning Corp., Troy, N. Y. Filed May 19, 1945. 8 claims. (Cl. 91-18.)

2,463,242. Coated abrasive article. Richard P. Carlton, assignor to Behr-Manning Corp., Troy, N. Y. Filed May 21, 1945. 1 claim. (Cl. 51-185.) These two patents are continuations of U. S. patents 2,318,570 (May 4, 1943) and 2,376, 342 (May 22, 1945) and relate to an abrasive sheet material.

2,463,244. Method of making adhesive tape. Edward J. Carter, assignor to William M. Scholl, Chicago, Ill. Filed Aug. 7, 1947. 3 claims. (Cl. 154-97.5.) A method of forming a layer of pressure-sensitive adhesive on a resin film with the paper embedded in the adhesive layer and stripping the casting web from the resin film.

2,463,274. Recovery of rosin acids. Alfred G. Houpt, assignor to American Cyanamid Co., New York, N. Y. Filed Sept. 27, 1945. 4 claims (Cl. 260-97.5.) This is a continuation of U. S. patent 2,285,902 (June 9, 1942). After separation of the major portion of the fatty acids as the sodium salts, the amyl alcohol filtrate is made acid with sulphuric acid in amyl alcohol, the amyl alcohol is removed by steam distillation, and the rosin acids are recovered.

2,463.302. Satchel bag having reinforced side walls and handle. Herman C. Orchard, assignor to Orchard Paper Co., St. Louis, Mo. Filed May 21, 1945. 4 claims. (Cl. 229-54.)

2,463,306. Carton securing means and method of using same. Roy C. Potts, Takoma Park, Md. Filed April 26, 1944. 9 claims. (Cl. 229-52.) A container is provided with a plurality of perforations in the closure flaps, into which are inserted wire closing devices.

2,463,313. Container. William A. Ringler, assignor to The Gardner-Richardson Co., Middletown, Ohio. Filed May 4, 1945. 5 claims. (Cl. 93-36.01.) A method for sealing a container.

2,463,375. Dispensing carton for paper rolls. Fred C. Gluck, assignor to Minerva Wax Paper Co., Minerva, Ohio. Filed May 25, 1945. 3 claims. (Cl. 206-58.)

2,463,452. Adhesive compositions are adhesive sheets. George W. Yule, assignor to E. I. du Pont de Nemours & Co., Wilmington, Del. A fibrous backing sheet has a tacky coating of polyisobutylene and dibutyl sebacate, with mineral oil as an extender.

March 8, 1949

2,463,757. Apparatus for the recovery of heat and chemicals from furnace gases. Frederic G. Ely and Charles E. Rogers, assignors to The Babcock & Wilcox Co., Jersey City, N. J. Filed Oct. 16, 1942. 3 claims. (Cl. 23-48.) A spray tower construction is designed for the recovery of heat and chemicals from the waste gases of a chemical recovery furnace for kraft black liquors.

(*continued on page 50 A*)

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(*continued from page 48 A*)

2,463,814. Dewatering apparatus. Harold A. Skinner, assignor to Marathon Corp., Rothschild, Wis. Filed Nov. 7, 1944. 4 claims. (Cl. 92-29.) Low-consistency stock is allowed to flow through an inclined pipe, a portion of which is equipped with wire mesh screen to permit removal of the water.

2,463,856. Production of laminated plastics. Gilbert K. Dickerman, assignor to Consolidated Water Power and Paper Co., Wisconsin Rapids, Wis. Filed March 22, 1943. 3 claims. (Cl. 154-138.) This relates to the manufacture of paper-base plastics.

2,463,983. Flameproofing composition. Earl W. Leatherman, Akron, Ohio. Filed Sept. 16, 1943. 7 claims. (Cl. 106-18.) A flameproofing agent is based on a thermally unstable chlorinated resinous material, a dechlorinating agent, and an inhibiting compound for prevention of the dechlorination of the resin at temperatures below 100°C.

2,463,992. Bag for merchandising. George A. Moore, assignor to Reynolds Metals Co., Richmond, Va. Filed March 16, 1946. 8 claims. (Cl. 229-62.) A semirigid bag is formed of a cradle of a metal foil laminated to paper sheet and a bag of the gusset type formed of heatsealing cellophane or Pliofilm.

2,464,065. Carton. Julius A. Zinn, Jr., Chicago, Ill. Filed March 19, 1947. 15 claims. (Cl. 229-14.) The construction of a lined carton described.

2,464,081. Modification of starch. Donald W. Hansen, Lowell O. Gill, and John H. Wrightsman, assignors to A. E. Staley Manufacturing Co., Decatur, Ill. Filed March 8, 1946. 11 claims. (Cl. 127-32.) Starch with 10–40% moisture content is subjected to the distorting action and pressure of cooled differential rolls (temperature below the starch pasting temperature).

2,464,131. Paper can body. Reynolds Guyer, assignor to Waldorf Paper Products Co., St. Paul, Minn. Filed July 25, 1945. 5 claims. (Cl. 229-4.5.) Cylindrical can bodies are formed by bending a plurality of flat sheets into tubular formation with one sheet overlying the other.

2,464,153. Crated sheet material package. Joseph Robinson, Jr., assignor to Marsh Wall Products, Inc., Dover, Ohio. Filed Sept. 12, 1945. 2 claims. (Cl. 206-60.) A method of packaging wallboards and similar sheets.

2,464,154. Partition for containers. Louis W. Roselius, assignor to S & S Corrugated Paper Machinery Co., Inc., Brooklyn, N. Y. Filed Sept. 19, 1947. 2 claims. (Cl. 229-15.) Waved double-faced corrugated board is used as a partition to divide a container into two or more cushioned receptacles.

March 15, 1949

2,464,278. Container and method of making same. Allen B. Wilson, assignor to Kimberly Stuart and Elizabeth R. B. Stuart, Menasha, Wis. Filed April 2, 1945. 6 claims. (Cl. 229-5.7.)

2,464,337. Handle reinforcing means for containers. James C. Morris, assignor to The Ohio Boxboard Co., Rittman, Ohio. Filed Aug. 12, 1944. 5 claims. (Cl. 229-52.)

2,464,342. Manufacture of waterproof and water-repellent noninflammable fibrous material. Frederick F. Pollak, Brooklyn, and Josef Fassel, Mamaroneck, N. Y. Filed April 16, 1943. (Cl. 117-137.) The material is impregnated with ammonium pyrophosphate and a melamine-formaldehyde condensation product and dried at an elevated temperature, thereby forming a water-insoluble melamine pyrophosphate.

2,464,360. Fire-resistant organic fibrous materials containing ethylenediamine dihydrobromide. Alexander J. Wesson and Henry C. Olpin, assignors to Celanese Corporation of America, New York, N. Y. Filed June 5, 1946. 5 claims. (Cl. 117-136.) Fire resistance is imparted to fibrous materials by impregnating with ethylenediamine dihydrobromide.

2,464,407. Folding box set-up machine. David Levkoff, Great Neck, N. Y. Filed Nov. 26, 1945. 6 claims. (Cl. 93-53.)

2,464,490. Continuous envelope assemblies. Herbert V. Davies, Putney, London, England. Filed Sept. 15, 1944. 2 claims. (Cl. 229-69.)

2,464,581. Apparatus for screening fibrous suspensions. Nils W. Jönsson, Lidingo, Sweden. Filed May 3, 1945. 1 claim. (Cl. 92-35.) The pulp suspension is passed through an upright screening mechanism rotated around a vertical axis, the screening mechanism being set in vibratory motion in vibration planes perpendicular to the axis of rotation.

2,464,611. Treating fermentable materials. Gustave T. Reich, Philadelphia, Pa. Filed March 27, 1945. 7 claims. (Cl. 127-48.) A method is described for removing calcium from sulphite waste liquor and the like.

2,464,640. Sanitary napkin. Charles A. Fourness, assignor to International Cellucotton Products Co., Chicago, Ill. Filed May 25, 1945. 5 claims. (Cl. 128-290.) The construction of a sanitary pad is claimed, the pad consisting of a layer of fluff and a layer of superposed plies of creped tissue paper.

2,464,657. Device for stretching, crimping, and twisting crepe paper. Chester E. Stephenson, Columbus, Ohio. Filed Oct. 16, 1947. 3 claims. (Cl. 41-1.)

2,464,759. Water-repellent coating composition and method of coating. Thomas P. Camp, assignor to United States Gypsum Co., Chicago, Ill. Filed March 30, 1945. 3 claims. (Cl. 117-65.) The coating contains paraffin wax (melting at 122 to 165°F.) and a petroleum-base asphalt.

March 22, 1949

2,464,783. Rubber coated resin saturated sheet and process of making the same. Edward R. Dillehay, assignor to The Richardson Co., Lockland, Ohio. Filed Feb. 28, 1945. 3 claims. (Cl. 117-80.) The sheet is saturated with a phenol resin, sprayed with a rubber cement, and cured at 300°F. and 1000 p.s.i. for 10 minutes.

2,464,828. Method of producing lignin from black liquor. Arthur Pollak, John J. Keilen, Jr., and Lewis F. Drum, assignors to West Virginia Pulp and Paper Co., New York, N. Y. Filed Feb. 22, 1944. 3 claims. (Cl. 260-124.) The black liquor is concentrated to remove the saponified resin salts, treated with carbon dioxide, and heated to precipitate the lignin.

2,464,904. Folding box. Harry A. Tomarin, Cincinnati, Ohio. Filed April 15, 1947. 5 claims. (Cl. 229-36.)

2,464,951. Display box. Jon Stengren, assignor to Edward McSweeney, New York, N. Y. Filed Dec. 14, 1945. 4 claims. (Cl. 206-45.19.)

2,465,044. Apparatus for making bags. Harold F. Shumann, Pittsburgh, Pa. Filed June 6, 1945. 1 claim. (Cl. 93-27.)

2,465,169. Display box. Richard P. O'Connor, Los Angeles, Calif. Filed Dec. 13, 1948. 6 claims. (Cl. 206-45.14.) A folding box suitable for display.

2,465,180. Apparatus for measuring the stiffness of flexible material. Ralph F. Taber, Buffalo, N. Y. Filed Dec. 8, 1945. 10 claims. (Cl. 73-100.) This is an improved stiffness tester previously disclosed in U. S. patents 2,063,275 (Dec. 8, 1936) and 2,113,389 (April 5, 1938).

2,465,243. Wrinkle coating composition. Enrique L. Luáces, assignor to New Wrinkle, Inc., Wilmington, Del. Filed Nov. 3, 1945. 1 claim. A wrinkle-coating composition consists of a resin resulting from the reaction at 400°F. of 60 parts of glycerol, 120 parts of phthalic anhydride, and 102 parts of fatty acids from cottonseed, corn, or peanut oil.

2,465,257. Laminated tubular article. Robert J. Nebesar, assignor to Universal Moulded Products Corp., Bristol, Va. Filed Sept. 12, 1945. 2 claims. (Cl. 138-78.) A tube is formed of a multiplicity of laminae of flexible sheets.

2,465,299. Laminated product embodying a low odor phenol-formaldehyde resin. Joseph J. Wachter, assignor to Westinghouse Electric Corp., East Pittsburgh, Pa. Filed Jan. 1, 1945. 5 claims. (Cl. 154-43.) A phenol-formaldehyde resin with practically no odor can be produced by the condensation in the presence of an alkyl amine; the product is suitable for a variety of papers.

2,465,324. Fiberboard shipping container. Stanley B. De Mian, Chicago, Ill. Filed July 24, 1944. 3 claims. (Cl. 229-44.)

2,465,327. Treatment of ground wood pulp. Robert L. McEwen, assignor to Buffalo Electro-Chemical Co., Inc., Tonawanda, N. Y. Filed Aug. 1, 1947. 4 claims. (Cl. 8-106.) Pulp is treated at pH 3.5 to 9 with hypochlorite sufficient to give an active chlorine content of 0.1 to 1.75% and then with an alkaline peroxide.

March 29, 1949

2,465,347. Recovery of sugar precursors. Robert M. Boehm and Horace E. Hall, assignors to Masonite Corp., Laurel, Miss. Filed March 31, 1944. 8 claims. (Cl. 127-40.) A method is given for the separation of pentosans and hexosans from the aqueous solution resulting from the Masonite process.

2,465,348. Method of making a conduit enclosing sheet product. Robert M. Boehm and George G. Simpson, assignors to Masonite Corp., Laurel, Miss. Filed March 31, 1945. 9 claims. (Cl. 154-118.) A method for enclosing pipes in fibrous blanks.

2,465,410. Calcining lime bearing sludge. Frank S. White, assignor to The Door Co., New York, N. Y. Filed June 28, 1946. 11 claims. (Cl. 23-186.) The lime-bearing sludge is mixed with an adhesive that melts below the decomposition temperature of the sludge solids, treated with an oxygen-bearing gas, and then heated at the decomposition temperature of calcium carbonate.

2,465,588. Collapsible box. Don B. Hartman, assignor to Owens-Illinois Glass Co., Toledo, Ohio. Filed Sept. 30, 1947. 8 claims. (Cl. 229-34.)

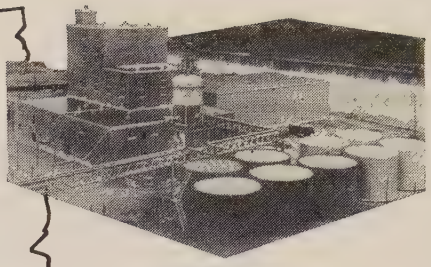
2,465,661. Collapsible hexagonal container. William A. Ringler, assignor to The Gardner-Richardson Co., Middletown, Ohio. Filed June 13, 1945. 1 claim. (Cl. 229-41.)

2,465,738. Method of bleaching mechanical wood fibers.

(*continued on page 52 A*)

World's largest recovery plant

PRODUCING ALCOHOL FROM WASTE SULPHITE LIQUOR IS GIVEN STAINLESS-CLAD PROTECTION



Bubble cap trays for 102″ vacuum rectifying tower; also made of a corrosion-resistant Lukens Clad Steel.

Section of beer still made from Lukens Type 316 Stainless-Clad Steel.

Pulp mill sulphite liquor, normally disposed of as useless, is the raw material, replacing molasses, from which Commercial Alcohols, Ltd., now makes industrial alcohol. This new plant at Gatineau, Quebec, has an annual capacity of over two million Imperial gallons. It was engineered and constructed under a contract with the Vickers-Vulcan Process Engineering Company, Ltd., a joint subsidiary of Canadian Vickers, Ltd., of Montreal, Canada, and The Vulcan Copper & Supply Company of Cincinnati, Ohio.

Because of the corrosive nature of sulphite liquor, all surfaces coming in contact with it are Type 316 stainless steel. Lukens Clad Steel, having this stainless steel as 15% of the plate thickness, provides this surface in the 102-inch, 62-foot-tall rectifying tower and in the fermented liquor or "beer" still.

Lukens Clad Steels—Nickel-Clad, Stainless-Clad, Inconel-Clad and Monel-Clad—let you select the surface you need to meet your problems. In each, a uniform cladding of the corrosion-resistant metal is permanently bonded to its backing plate, giving you *solid* metal protection at the lower cost of *clad* steel. All are available in the extra-smooth sodium hydride finish.

You may have copies of Bulletins 449 and 470 telling you more about Lukens Clad Steels. For copies, write Lukens Steel Company, 501 Lukens Building, Coatesville, Pa.

CLAD METAL STEEL

LUKENS

Nickel-Clad Stainless-Clad
Inconel-Clad Monel-Clad
STEELS

SOLID METAL ADVANTAGES WITH CLAD STEEL ECONOMY

(*continued from page 50 A*)

Robert L. McEwen, assignor to Buffalo Electro-Chemical Co., Inc., Tonawanda, N. Y. Filed Dec. 22, 1945. 3 claims. (Cl. 8-104.) Groundwood fibers at consistencies of 20 to 35% are moistened with an alkaline peroxide solution and bleached at a temperature between 40 and 80°C.

2,465,841. Package. John H. Bonini, assignor to Marathon Corp., Rothschild, Wis. Filed March 15, 1946. 1 claim. (Cl. 229-87.) A method for packaging sliced bacon and the like.

2,465,842. End closure for paperboard containers. Lewis C. Brooks, assignor of one third to Ira M. Jones, Milwaukee, Wis. Filed March 12, 1945. 2 claims. (Cl. 229-5.5.) An end closure for a multiple-sided container.

2,465,927. Decalcomanias. Melville B. Rapp, Miami Beach, Fla. Filed April 13, 1946. 1 claim. (Cl. 154-46.8.) A plurality of separate decalcomanias arranged in substantially coplanar relation.

2,465,949. Sealed reclosable carton end structure. Marshall I. Williamson, assignor to National Folding Box Co., Inc., New Haven, Conn. Filed Feb. 12, 1945. 2 claims. (Cl. 229-38.)

Standard Terms Used in the Sulphite Pulping Process

Revision of Tappi Tentative Standard O 406 p-48

1. *Total Sulphur Dioxide:* Total SO_2 as determined by titration according to TAPPI Standard T 604 m, and expressed as Per Cent Total SO_2.
2. *Free Sulphur Dioxide* (more properly called "available" SO_2): The sum of the actual free SO_2 plus one half of the SO_2 combined as bisulphites as determined by titration according to TAPPI Standard T 604 m, and expressed as Per Cent Free SO_2.
3. *Combined Sulphur Dioxide* (more properly called "nonavailable" SO_2): The SO_2 combined with the base as monosulphite. Determined by difference, substracting the Free SO_2 from the Total SO_2, and expressed as Per Cent Combined SO_2.
4. *Sulphur Dioxide:* SO_2 gas made by burning sulphur or pyrites with sufficient air to form SO_2.
5. *Bisulphite Liquor Base:* Alkalies or alkaline earths used in the preparation of bisulphite cooking liquors. These may include calcium, magnesium, calcium and magnesium in combination, sodium, and ammonium, used in the form of lime or limestone, dolomitic limestone, magnesium oxide, soda ash, and ammonia, respectively.
6. *System Acid:* Bisulphite liquor prepared by combination of SO_2 and base in the presence of water, with excess SO_2 in solution. Also known as Tower Acid or Raw Acid. In a two-tower absorption system the liquor from the first tower is sometimes called Strong Acid (or Strong Liquor) and that from the second tower Weak Acid (or Weak Liquor).
7. *Storage Acid:* System acid in reserve, for transfer to acid accumulators for fortification by injection of additional SO_2. Also sometimes known as Raw Acid.
8. *Accumulator Acid:* Storage acid held in pressure vessels during fortification by the SO_2 in digester-relief gas or by the addition of liquid SO_2.
9. *Cooking Liquor:* Accumulator acid after fortification is completed and ready for use in the digester cooking operation. Also known as Strong or Finished Acid.
10. *Digester Liquor:* Cooking liquor as it exists in the digester at the various stages during the progress of the cooking operation.
11. *Digester Top Relief:* Gas (or liquor, when the digester is heated by direct steam) withdrawn from the top of the digester during the early stage of the cooking operation and returned to the accumulator (or reclaiming system) to conserve SO_2 and heat.
12. *Digester Side Relief:* Digester liquor withdrawn by side relief from the upper section of the digester in the early stages of digestion and returned to the accumulator or storage to conserve SO_2 and heat.
13. *Digester "On-Side" Test:* Test of the digester liquor for Total, Free, and Combined SO_2 just before the digester is put on side relief.
14. *Digester "Off-Side" Test:* Test of the digester liquor for Total, Free and Combined SO_2 just after the digester is taken off side relief.
15. *Digester "Blow-Down" Test:* Test of the digester liquor for Total, Free, and Combined SO_2 at the beginning of the pressure-relief period toward the end of the digestion.
16. *Digester "Blow" Test:* Test of the digester liquor for Total, Free, and Combined SO_2 just before the digester is blown.

Note: The determinations in items 13, 14, 15, and 16 are made by the procedures referred to in items 1, 2 and 3.

17. *Sulphite Waste Liquor:* Spent liquor from sulphite digestion containing the dissolved constituents of the wood and removed from the pulp as the digester is blown.
18. *Sulphur Consumption:* Pounds of sulphur (from elemental sulphur, pyrites, or SO_2) consumed per ton of air-dry pulp, determined from operating and inventory records.
19. *Limestone, Lime, etc., Consumption:* Pounds of base material consumed per ton of air-dry pulp, determined from operating and inventory records.

CORRECTION—T 227 m-46—FREENESS OF PULP

In the description of the freeness tester, under Apparatus, the size of the perforations should be 0.02 inch diameter instead of 0.20 inch diameter.

That's a MARKET going to pieces!

WET-STRENGTHEN your paper with Uformites

When paper towels disintegrate into sopping shreds, somebody's due to lose business—probably the papermaker who neglects to wet-strengthen his paper.

Too bad—especially since UFORMITE 475 gives high wet strength plus maximum absorbency at low cost. As little as $4 per ton of paper boosts wet Mullen values 300%, raises dry Mullen and fold values 10 to 30%, and increases wet rub and scuff resistance, wet and dry tensile.

In paper toweling, UFORMITE 475 eliminates the see-saw relationship that has made a strong, absorbent towel a hard-to-realize ideal. In twisting tissue, too, the rosin prevents breakage on paper-twisting machines. And in bags; reproduction or printing papers; glassine; tasteless, odorless, grease-proof wrappings, the UFORMITES provide the high wet strength your customers want.

And low price is not the only saving. With the UFORMITES, there's no pretreatment necessary, no special processing or equipment. Just add UFORMITE 467 (for kraft bags, etc.) at the beater, or UFORMITE 470 (for high pH kraft, groundwood, and sulfite) anywhere at the wet end after the Jordans. With the UFORMITES, you'll improve the sizing efficiency of rosin and the retention of beater additives. For full information on UFORMITES—plus samples of these resins—write today. There's no obligation.

UFORMITES for Paper

Your copy of this free booklet will answer your technical questions about the UFORMITES, and how they are used to increase wet strength. Send for it today.

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AMBERLITE W-1—A water soluble polymer for improving the dry and wet tensile and Mullen, as well as the fold and the abrasion resistance of paper.

RHOZYMES BB and E-5—for enzyme conversion of starch.

TAMOL N—for effective pitch control—a dispersing agent for pigments.

TRITONS—Surface-active agents with a score of uses in paper manufacture—in caustic cooking of cotton fiber, as a dispersing agent for pigments and metallic soaps, emulsion-type coatings.

The Hydrosulfites—Reducing agents for stripping color from rag stock or for bleaching pulp.

HYAMINES—Deodorants for paperboard and glue bactericides.

UFORMITE, AMBERLITE, RHOZYME, TAMOL, TRITON, HYAMINE *are trade-marks, Reg. U. S. Pat. Off.*

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Report of TAPPI Nominating Committee

The TAPPI 1950 Nominating Committee, consisting of Henry J. Perry, Chairman, H. W. Charbonnier, C. H. Child, J. R. Dufford, and H. E. Karberg have presented the following nominees for officers and executive committeemen to be voted on by the membership prior to the TAPPI annual meeting in 1950.

President (one year): Albert E. Bachmann, Missisquoi Corp., Sheldon Springs, Vt.
Vice-President (one year): Kenneth P. Geohegan, Aetna Paper Co. Div., Howard Paper Mills, Dayton, Ohio
Executive Committeemen (three years):
K. O. Elderkin, Crossett Paper Mills, Crossett, Ark.
Milton Jacobs, Chas. T. Main, Inc., Boston, Mass.
Ralph W. Kumler, American Cyanamid Co., New York, N. Y.
George E. Shipman, Donnaconna Paper Mills, Ltd., Donnaconna, Que.

Note: Article VII, Sec. 3, TAPPI Constitution: "Other nominations, if signed by at least 25 voting members, may be submitted to the Secretary of the Association, in writing, on or before November 20; and if each nomination so made is accepted in writing by the nominee, the name shall be placed on the official ballot."

New Committee Chairmen

James R. Lientz, General Superintendent, Pulp and Paper Div., Union Bag & Paper Corp., Savannah, Ga., has been appointed Chairman of the Chemical Engineering Committee in the TAPPI Engineering Division. This committee was recently transferred to the Engineering Division from the Research Development Division. Mr. Lientz succeeds Roy P. Whitney of the Institute of Paper Chemistry.

C. E. Brandon, Chemist, Aetna Paper Co. Div., Howard Paper Mills, Dayton, Ohio, has been appointed Chairman of the Microscopy Committee in the TAPPI Testing Division to succeed Thomas Fyfe, Eastman Kodak Co.

TAPPI Standards

Roger C. Griffin, Chairman, TAPPI Standards Committee, has announced that as a result of the recent Association ballot the following Tentative Standards have been advanced to Official Standards:

E 203 p-44 Paper Machine Drying Rate
T 460 m-46 Air Resistance of Paper

Engineering Conference Paper Mill Visits

Edward T. Jones, Chas. T. Main, Inc., Secretary, Arrangements Committee, Fourth Engineering Conference of the Pulp and Paper Industry, has advised that the following paper companies are agreeable to having engineers attending the Engineering Conference in Boston (Oct. 31 to Nov. 3) visit their mills at that time:

A. L. Adams Paper Co., Baldwinsville, Mass.
Bird & Son, E. Walpole, Mass.
Doeskin Products, Inc., Wheelwright, Mass.
Champion International Co., Lawrence, Mass.
Erving Paper Mills, Erving, Mass.
Falulah Paper Co., Fitchburg, Mass.
Fitchburg Paper Co., Fitchburg, Mass.
Robert Gair Co., Haverhill and Natick, Mass.
Merrimac Paper Co., Lawrence, Mass.
St. Regis Paper Co., Pepperell, Mass.
Stoney Brook Paper Co., Div. of American Products Co., Waltham, Mass.
Tileston & Hollingsworth, Hyde Park, Boston, Mass.

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THE 3" THICK STEBBINS CARBON BRICK LININGS,

the result of fifteen years research to perfect a thin brick lining for sulphate digesters and auxiliary equipment, in place of 5" thickness, is now available to:

minimize the loss of digester volume due to space occupied.

be readily installed in existing digester shells

prove resistant to all types of corrosion encountered under varying cooking conditions

place no limitation on operating procedure

be resistant to thermal shock

be resistant to abrasion

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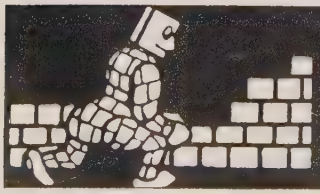
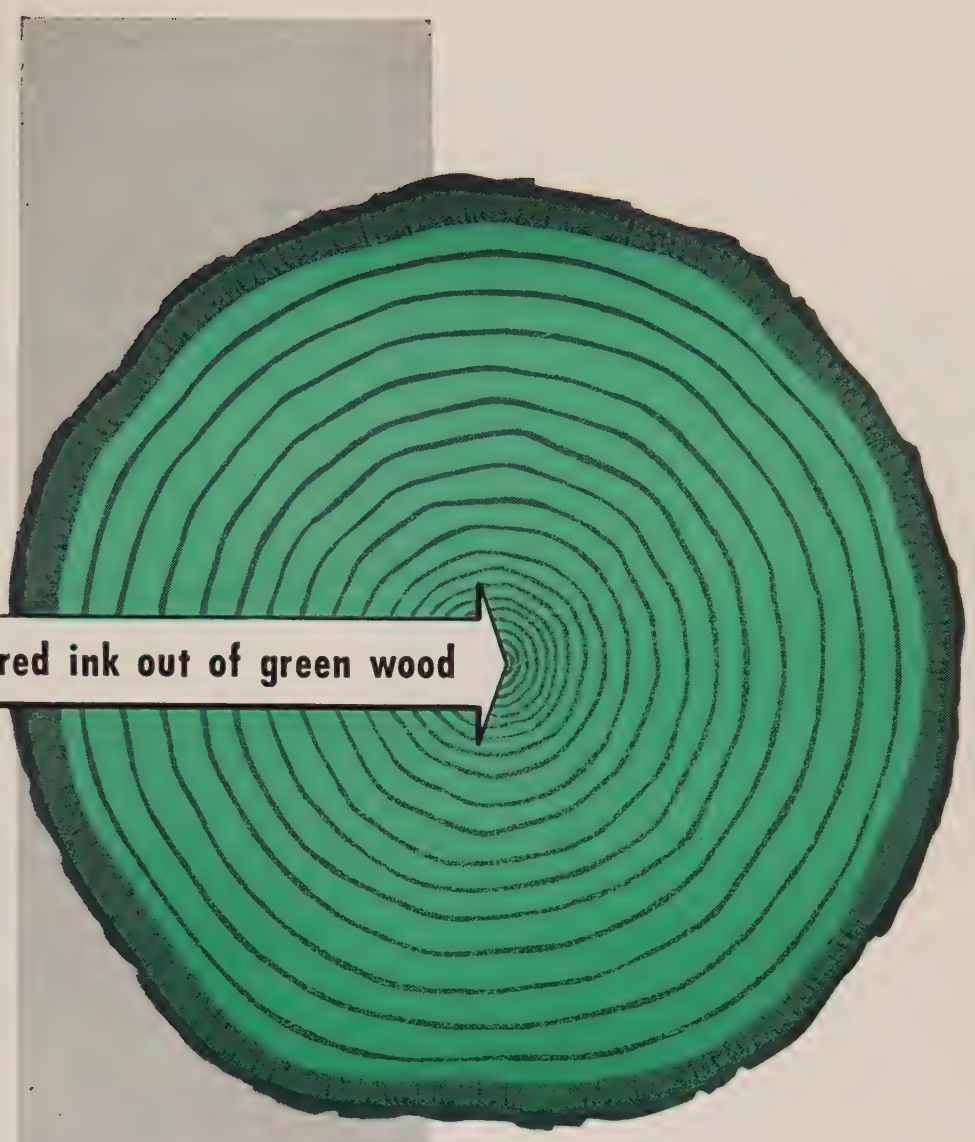


SEMCO
Stebbins Engineering and Manufacturing Company
EASTERN BOULEVARD, WATERTOWN, NEW YORK



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Today, profit-wise mill owners reduce costly shut-down time, speed production by keeping pitch dispersed with Mertanol 7L. This synthetic organic sulfonate, developed by Monsanto research, eliminates expensive pitch troubles prevalent in summertime and in unaged wood:

Spotted paper, plugged screens and wires, stuck paper on drier cylinders and pitchy felts are all eliminated by adding as little as 2 to 6 pounds of Mertanol per ton of dry stock at the paper beaters.

With summer (and more green wood) on its way, you will want more information now on Mertanol 7L.
Clip the handy coupon below. Mertanol 7L: Reg. U. S. Pat. Off.

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Desk TAPPI, Boston 49, Mass.
Please send me full information on Mertanol 7L for pitch control.

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Firm _____
Address _____
City _____ Zone _____ State _____

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LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel and Events

Lake States

Left to right: Kenneth P. Geohegan, George R. Sears, Alan P. Adrian, Henry C. Crandall, Alfred M. Heald, and Martin L. Downs

The TAPPI Lake States Section heard K. P. Geohegan, Vice-President of TAPPI and Vice-President of the Howard Paper Mills, talk and lead a discussion on pulp evaluation at the Butte Des Morts Golf Club in Appleton, Wis., on May 17. Dr. A. M. Heald of the Marathon Corporation, retiring chairman, announced the result of the mail ballot and presented the new officers and executive committee. They are:

Chairman: George R. Sears, The Institute of Paper Chemistry
Vice-Chairman: Henry C. Crandall, Mosinee Paper Mills Co.
Secretary-Treasurer: Alan P. Adrian, Neenah Paper Co.
Executive Committee: Herbert W. Rowe, Nekoosa-Edwards Paper Co., John N. McGovern, Forest Products Laboratory, Linton E. Simerl, Marathon Corp., and Alfred M. Heald, Marathon Corp.
Representative of National Executive Committee: Martin L. Downs, Thilmany Pulp and Paper Co.

In his talk, Mr. Geohegan briefly traced the development of pulp evaluation in the industry and then gave a detailed account of the experience and procedure of the laboratories of his company. His talk follows:

The Problem of Strength Testing of Pulp

"Tonight, we are scheduled to discuss the methods of testing the strength of pulp; an intriguingly controversial subject. As you all know, the most uniform characteristic of these methods is their lack of uniformity. It is easy to see why.

"Many mill laboratories commenced testing pulp before it was possible to buy any of the ready-made equipment that is available today. Having accumulated experience based on their home-made apparatus, they are justifiably reluctant to discard this experience in favor of a more standard method that would permit them to check, at most, only a few other laboratories.

"Those of us who commenced our pulp testing more recently chose between a number of well-designed pieces of apparatus. For beating the pulp, there is the ball-mill, the kollergang, and several types of laboratory beaters. For making hand-sheets, there is the equipment described in TAPPI's T 205 m-47, as well as the Valley, Williams, Noble & Wood, and other equipment. Each system offers advantages with accompanying disadvantages. Each of us has chosen the combination that appeared best suited to his particular needs and has, in most instances, devised his own beating, sampling, and testing procedure.

"To attempt to translate into common language the results of this confusion is a task that makes the problem of the Tower of Babel appear simple. In spite of that, I hope that we can deduce a few generalities and then, in a general discussion, develop some ideas that may help those who are trying to standardize pulp testing on a more fundamental basis.

"First, I would like to recount our own experience. Not that I feel that we have been more successful than others in our efforts to establish a relationship between our pulp testing and our mill results but because ours is an isolated case that is representative of the way laboratory practice has developed. Moreover, it calls attention to many of the factors that must be considered in choosing a testing procedure. I wish that this paper could have been given by my colleague, C. E. Brandon. He is responsible for having developed the procedure we use, and is much more familiar with the details than I. He has made an exhaustive study of the variables in our tests, and furnished the data that I am presenting here.

"Our primary aim was the same as that of most papermill laboratories, namely, to develop a laboratory treatment of pulp that would approximate, as closely as possible, the results to be expected on our paper machines. With this in mind, we decided on a laboratory beater in preference to a ball-mill or a kollergang, as we felt it simulated better the action of our refining equipment. We were not sufficiently familiar with the action of the kollergang to feel justified in adopting it. Although we appreciated the advantage of the reproducibility of the ball-mill results, we felt that the cutting action of the beater was more important. The results that we have seen since then have appeared to confirm our feeling that the lack of cutting makes ball-mill testing unsuited to predicting the strength that will be developed by commercial refining equipment.

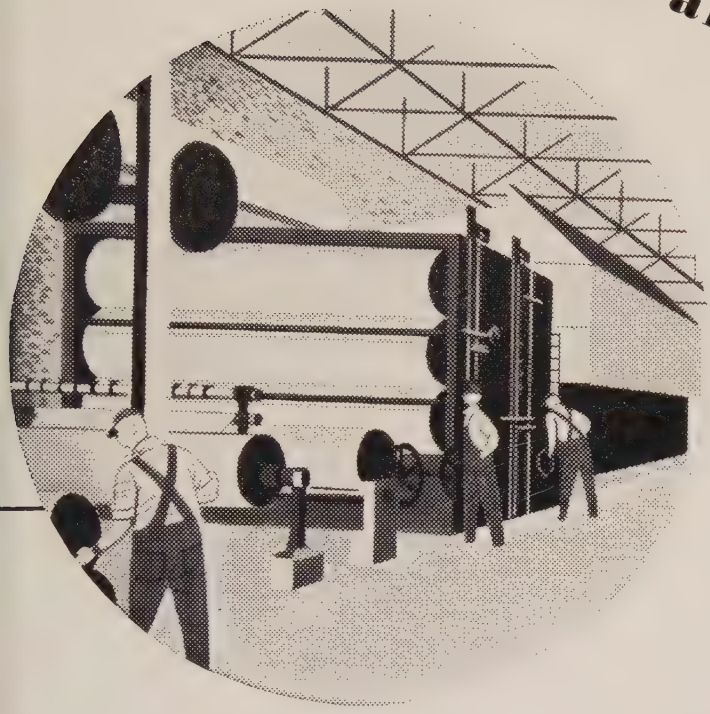
"I believe that it is important for me to indicate the equipment that we chose and some of the reasons that led us to select it. Doing so will give you a better basis for forming your own opinions of the significance of our results. However, I do not wish to be in the position of appearing to recommend it in preference to other equipment. The advantages for which we bought it are accompanied by the usual inevitable disadvantages, but we are more than satisfied with our selection. On the other hand, we might have been just as well pleased, or even better, with equipment from another manufacturer.

"We chose the 5-pound beater and the hand-sheet equipment manufactured by the Noble & Wood Machine Co. We liked the beater's large capacity that permits frequent sampling; also its system of circulation that makes possible beating up to 6% consistency. We liked the almost automatic reproducibility of the hand-sheet equipment, its de-

(*continued on page 58 A*)

DOW CHEMICALS

for the pulp and paper industry



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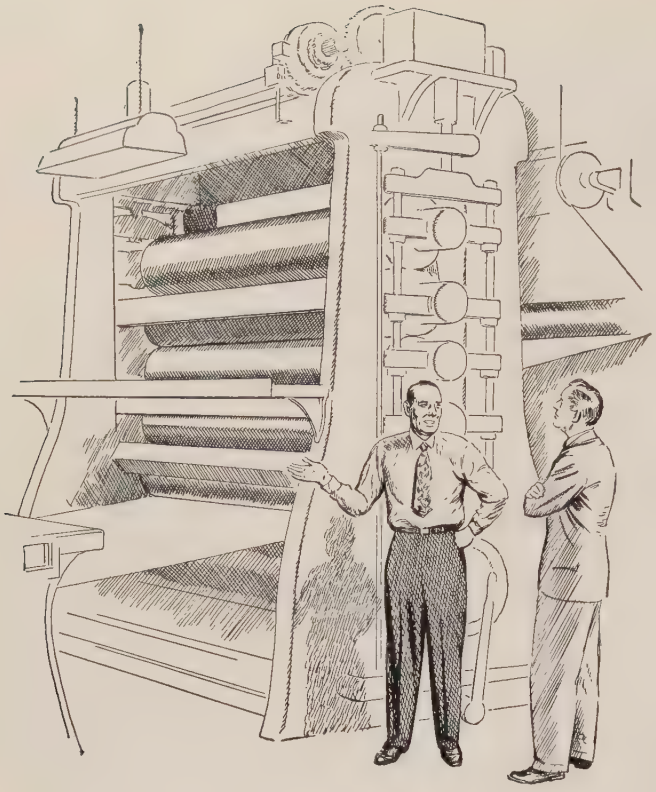

"One Butterworth Roll showed the difference"

"With just one Butterworth Calender Roll in the stack, we saw the difference in paper finishes —uniform surfaces, better calendering. Our time records showed it outran other rolls in the stack. Now that we've standardized on Butterworth Rolls, we've had many additional hours of service, increased production and less time lost."

Butterworth Calender Rolls are made of first quality materials and to exact specifications. That is why they can be depended upon to produce outstanding finishes during calendering operations. Once Butterworth Rolls are in use in your calender, your own records will show you the economy of standardizing on these finer Calender Rolls. No matter what kind of calendering you do, we can furnish you with rolls made to your requirements. We can also refill your present rolls. Write us today for details.

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Butterworth Calender Rolls

vice for adjusting the weight of the hand sheets, their size, and the rapidity with which they can be made. We had a Williams slowness tester and used it.

"Our first step was to experiment with variations in consistency, roll weight, and beating time, in an attempt to duplicate the results of our mill refining equipment. To do this, we tested hand-sheets made from stock from the beaters, from the jordans, and from the head-box. We also tested the finished paper. Then we tried to duplicate these tests in hand-sheets from our laboratory beater, aiming chiefly at the tests from the jordans, but taking into account the tests from the head-box and on the finished paper, and using the same furnish.

"We found that the Mullen, fold, tear, and slowness developed together in the proper relationship. However, the Mullen-fold combination reached the desired values in the laboratory beater long before the tear-slowness. We were unable to bring the two groups together by any changes in the consistency, roll pressure, or beating time. We also found that at a consistency of 4% or greater, the stock moved irregularly around the beater and that the results were not as reproducible as at a lower consistency. We finally selected a consistency of 3.75% and a roll weight of 50 pounds.

"After comparing our laboratory results against mill samples for a wide variety of furnishes, we adopted the expedient of selecting as our "predicted" tests, the Mullen and folding endurance after 15 minutes beating time and the tearing resistance and slowness after 45 minutes.

"Using this procedure, we made check tests on a number of lots of pulp and were satisfied that our tests were reproducible within reasonable limits. From check tests made more recently, Mr. Brandon has calculated the following average percentage differences between two beater tests on the same lot of pulp: Mullen $3^1/_2$, fold 21, tear 5 and slowness 19.

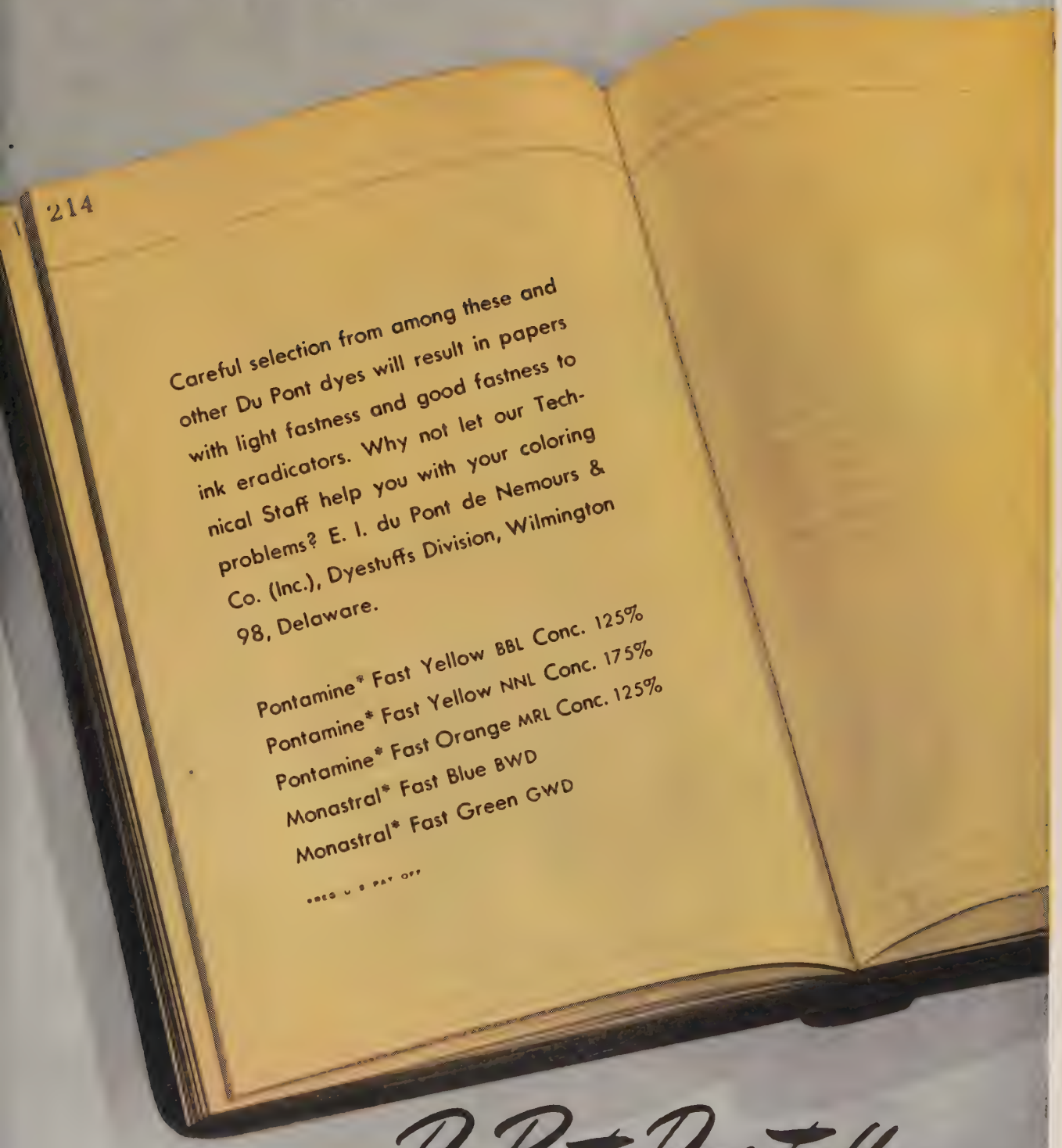
"There still remained the question that has caused so many laboratories to resort to ball-mill tests: How much will the beater change with use? There were two procedures that we could follow. First, we could regrind it periodically and expect periodic fluctuations in our tests. We decided to run the beater without regrinding on the theory that a thoroughly dulled beater can not become much duller. So, for eleven years, we have been keeping our fingers crossed, particularly as we have been using it extensively for beating rags. We have also been watching our results most critically. Of course, it is extremely difficult to detect changes over a long period. If you save samples of pulp for retesting, you never know how much the pulp has changed. So, a little more than a week ago, when it became necessary to regrind our beater, we were not only interested in the outcome, but fearful of what we might find. The bearings finally wore to such an extent that they had to be replaced, thus changing slightly the position of the roll and making it necessary to grind it into place.

"There has not been time for use to determine accurately how much our results have changed. However, from the check tests that we have made, we believe that it is safe to say that the average change is less than 15%; less than that, of course, in the case of Mullen and tear, and greater in the case of fold and slowness. It is definitely encouraging that the differences are less than we are accustomed to consider to be significant in comparing different pulps.

"Having given you the background of our testing procedure, I would like to describe two of our experiences that I feel should be considered in a discussion of the possibility of correlating better the results of different laboratories. First, let me say that our procedure, imperfect though it is, has been remarkably effective in predicting what mill results we can expect on our machines from the pulp that we receive.

(*continued on page 60 A*)

For fastness to ink eradicators



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"During the war, we made a large amount of one grade of paper from a furnish of about 85% bleached sulphate pulp that we received from two sources. This gave us an unusually good opportunity to study the comparative strength development. Pulp A developed higher maximum Mullen and fold in the laboratory beater than did B; whereas B developed its strength more rapidly. According to the widely used system of rating pulp on the basis of its maximum Mullen, A appeared stronger. According to the method of selecting a sample early in the beating cycle, the advantage lay with B. In both of the two mills where we made this grade, we were never able to develop as much strength from A as we were from B.

"During the last two or three years, our laboratory pulp tests have indicated lower Mullen and fold than shipments of the same grades that we received before the war. Some grades show this more than others but it is true of every grade that we have been receiving. The obvious explanation would seem to be that there has been a change in our laboratory beater. However, the same difference is apparent in the paper made at all three of our mills, and also in our competitor's papers. The pulp-mill laboratories, to which we have submitted this question, do not find this difference. Our experience since regrinding our beater appears to confirm the fact that the difference is there. What is the answer? It seems that it must lie in the difference between their methods of testing and ours.

"So, we have returned to our original premise: There is a need for a common language in evaluating pulp tests. Before even considering how this might be done, let's define the problem more specifically.

"I think that we can assume that all laboratories will do as they have in the past and, just as we did, fit their testing procedures to their own mill conditions. Even if all were to use the same equipment, the confusion would be just about as great as it is today.

"The laboratories of mills making market pulp will always be faced with the fact that their customers have a wide variety of refining equipment and different needs. Mills that make pulp for their own use in paper would appear to be in a better position but, I have a feeling that differences exist between their pulpmakers and their papermakers as to how the pulp should be tested and what are the desirable characteristics.

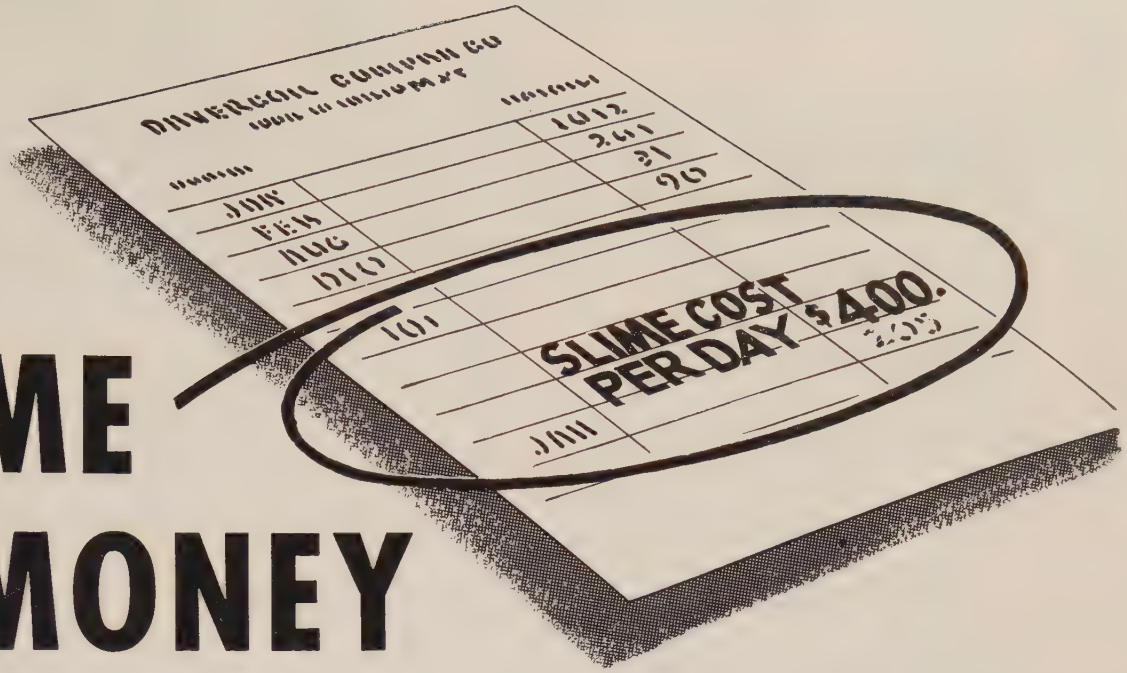
"Somehow, we should try to find a common basis for evaluating our pulp tests, regardless of how they are made. Moreover, for correlating our laboratory tests and our mill results, we need a basis that is more fundamental than the empirical comparison we are now using.

"How is this to be accomplished? I submit the following suggestions with my tongue in my check, for I realize the difficulties. Also, I realize that every one of you is better able than I to develop a practical plan. So I submit the following more as a basis of argument than as my well-defined opinions. If they cause a discussion that develops some worthwhile ideas, they will have served their purpose.

"It seems to me that the common denominator that we must use in judging our pulp tests, must be based on the three fundamental changes that we know take place in refining: cutting, splitting (including fibrillation), and that much-disputed thing called "hydration."

"Yes, I believe that a factor exists, call it "hydration" or what you will, in addition to the others I have mentioned. How else will you explain the change that takes place in the drainage rate of a pulp suspension after it has been boiled and then brought to the original temperature? As Mr. Brandon has suggested, this "hydration" may be a change in cellulose from the crystalline to the amorphous state that reverses at a higher temperature. Or it may be imbibition or adsorption of water.

(*continued on page 62 A*)



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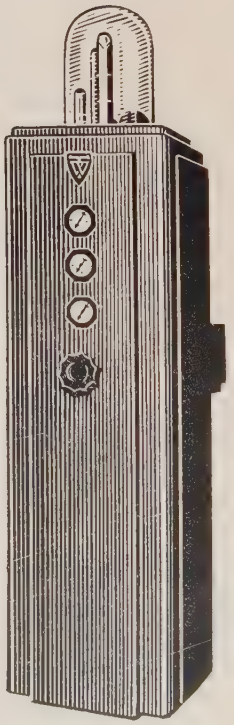

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"Work by Dr. Bialkowsky, confirmed by some results we have received since, indicates that pure cutting changes drainage rate very little if at all. Perhaps, that may be a starting point for separating these factors. Dr. Clark's method of determining specific surface of pulp is a big step in the right direction.

"Perhaps a fundamental study of the factors affecting drainage rate might lead us somewhere. Mr. Brandon has obtained definite evidence that more can be learned from a comparison between sheet-mold drainage-time and the Williams slowness test than from either alone. The possibility of learning much by a more critical study of fiber classification is obvious.

"I wish to close by offering you for discussion the possibility of correlating pulp tests by basing them on the strength developed, not after so many minutes beating time or at a certain freeness, but at a stated amount of cutting, splitting, and "hydration."

Note: A long, interesting and informative discussion of Mr. Geohegan's talk followed. It is unfortunate that no record of this was made for publication.

Delaware Valley

The TAPPI Delaware Valley Section met at the Engineers Club, Philadelphia, Pa. on Thursday, May 26. John P. Weidner of the Container Corp. of America, Chairman, presided.

R. G. Macdonald, Secretary of TAPPI was introduced and helped introduce the speaker James L. Ritchie of the United States Pulp Producers Association who talked on "The Current and Long Range Picture of the Wood Pulp Situation." (See page 20 *A*).

The Wood Pulp Situation Long Range

Mr. Ritchie's presentation will be published in full, in *Tappi*. Following is a report of the general discussion of his talk. The answers given are a composite of the replies by Messrs. Ritchie and Macdonald.

Question: I would like to ask what the other industries are doing about forest conservation and who is responsible for great wastes since only 6 to 13% of the total wood cut has been used for pulp wood. That is still a rather small part of the whole.

Answer: The lumber industry is responsible for the largest percentage of wood cut. Since a large share of the cut is made by small operators with relatively small capital investment and using mobile equipment, little has been done by them on forest farming. These factors are not true of the paper industry where the equipment is immobile and involves large capital investments. Therefore the paper industry has a greater interest in establishing sound forest practice to safeguard their economic future. Greater progress has been made by the pulp and paper industry in forest conservation than by any other group. There are a few larger sized units in the lumber industry now doing some conservation along this line.

The use of wood as fuel is also a very difficult problem to control because it involves so many small private owners. It is in the smaller industries where the educational work must be done.

Question: Wouldn't there have to be a similar increase in the use of paper to justify such an expansion in pulp production as indicated by the long-range forecast? It is already high.

Answer: It is true that paper usage developments must justify the increase in the pulp production forecast. A lot of new products were developed during the war years, but with the shortage of fibers, and capacity, not too much was done about them, but now that these shortages are no

(*continued on page 64 A*)

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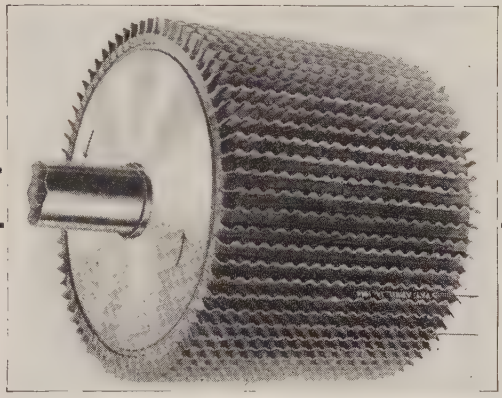

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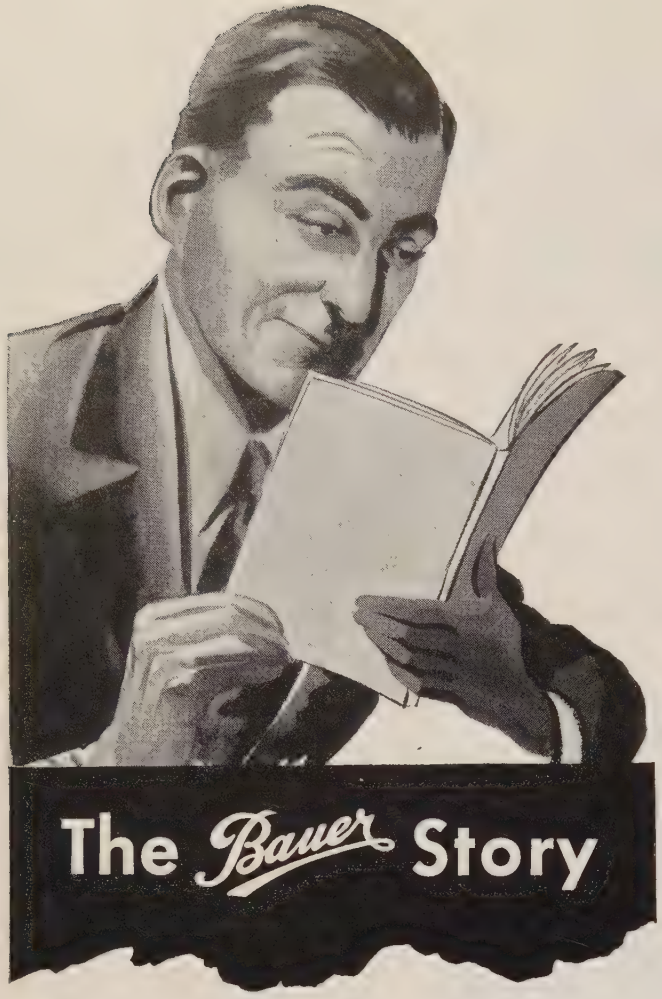

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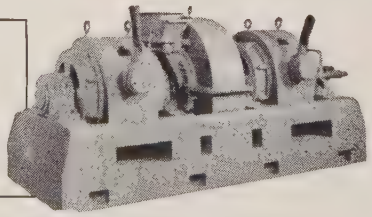

longer a factor, much greater effort will likely be given to increasing the market for new products than through increasing the use of old products. I think Mr. Macdonald can tell you more about this.

Mr. Macdonald: In the past the per capita consumption of paper was influenced by the printing and publication requirements. More paper should be required to fill the requirements of the increased educational programs being planned, although against this trend there is said to be the possibility that radio and television may reduce the demand for publications. The greater increase in the potential paper market will be due to new products made of paper. It has been said that paper can be substituted for everything, but that there is no substitute for paper. Industrial uses and packaging take up the greater part of paper tonnage.

Among the new uses are packaging for frozen foods, and there are many things made of paper which do not look like paper in the finished products, e.g., plastics made up from layers of paper and laminated with plastic resins. The lumber industry reached its peak around 1909 and came up some during the war, but not to the peak of 1909. The pulp industry is also entering the textile field through the manufacture of rayon, etc.

Question: What part will exports play in the increased supply of pulp?

Answer: Pulp and paper is the biggest single item of import, but with the wood situation as it is, the world over, the opportunity of development is greater on the North American continent than for any other place in the world because of economic and technical capacities. It is possible that the United States and Canada will become a real factor in the export market.

Question: What is the situation in this hemisphere on a sustained yield basis?

Answer: Economics is forcing the paper industry to move toward that goal. The main problem today is that you have about one third of the forest land held by farmers and about one third of the pulp wood cut is made by farmers. A sustained yield program can be achieved in two ways: (1) by education—teaching the farmers that such a program is for their own economic welfare; or (2) by legislation—either Federal or State. Industry prefers the first method because it is faster and better.

Question: How are you going to achieve this unless the other wood using industries also take up this type of program?

Answer: They get their wood in different ways and means. Some own their own land or wood, but a large part is bought from farmers and independent contractors. Wherever they operate on their own land, they can control the program over their own holdings.

Question: Isn't the Government the worst offender in discouraging such a program by their tax and regulation policies?

Answer: I have been told that this situation is the case in Maine and several other states where it would not pay any one to carry out a conservation program because one couldn't afford to pay the high taxes on the land.

Question: How long are the logs that can be used on the new chippers?

Answer: (Comment from floor) 40 foot logs can be taken on these chippers. 30 foot logs are common with diameters from 36 to 40 inches. The weight limits of the loading cars limits the size of the logs than the potential capacity of the logs.

Question: What change is there due to the domestic consumption of pulp?

Answer: The production for the first quarter of 1949 was 3,344,000 tons of domestic pulps and 395,000 tons foreign imports. The total production was up 2% but the imports were down.

(*continued on page 66 A*)

BARRELL'S

PAPER ANNUAL

1949-1950

Presented as a Service to Members of the Paper Industry

WILLIAM L. BARRELL COMPANY
LAWRENCE, MASSACHUSETTS

VOL. VIII
1949-1950

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(continued from page 64 A)

Question: How does this compare with conditions before the war?

Answer: The largest pulp imports were made in 1937. Today the sources are different. You are almost back to the level of the 1937 imports of pulp, but in 1937 the bigger volume came from the Scandinavian countries. Now it comes from Canada. The trend now is for governments to prevent the export of cheaper grade pulps or pulp wood, and favor the export of high-grade pulps or paper.

Question: What was the reason for the recent change in policy on prices of pulp from Scandinavian countries? For no apparent reason they suddenly cut prices far below the domestic pulp prices.

Answer: The shortage of pulp the world over just after the war brought premium prices for pulp and the Scandinavian market took advantage of this situation while the domestic pulp industry maintained a more conservative price policy. The foreign pulp market went out to get all that the traffic would bear and as a consequence they were able to get $50 to $60 per ton more for pulp than the domestic pulp producers were charging. Since that time the bottom has fallen out of the market and sales were 17% lower last year than during the period of shortage. Consumer inventories had been built up and consumption was falling off. The demand was less and new production was coming in. The market situation had changed from an over-demand side to an over-balance of supply and prices were cut to undersell the conservative domestic market in order to create a new market for their pulp. This caused the domestic prices to fall also.

Another explanation is that Sweden has a socialist government based on an equalized economy policy. The government charged $10 per ton over the regular priced to build up the treasury and keep the socialist government going during the period of demand. The mills have a social responsibility, e.g., in a small town a mill is held responsible for the economic welfare of all the people and must employ more than they need and supply in addition certain utilities to the town, etc.

Some visitors from Italy and other countries described their socialized industries which are forced to employ as many as 4 to 5 times the number of employees needed. Their plants are not operated as a business but as a social project.

Maine-New Hampshire

The Maine-New Hampshire Section has cooperated with the University of Maine, at Orono, Me., during the past school year in the sponsoring of three series of lectures. The lectures have been presented to students enrolled at the University for college credit in the courses of Pulp Technology, Paper Technology, and Pulp and Paper Mill Equipment. Enrollment in these courses ranged from 17 to 25 students. The lectures were also open to visitors from neighboring mills.

A proposal for the lecture series was presented to the Executive Committee of the Section at the June, 1948, meeting by Professor Lyle C. Jenness, Head of the Department of Chemical Engineering at the University. Since that time committee members, and other members of the Section, have cooperated with Professor Jenness in arranging for speakers to present lectures at the University. A total of 42 lectures were given during the year. Although a large percentage of the speakers were from mills in the State of Maine, the States of New Hampshire, Massachusetts, Connecticut, New York, Michigan, and Washington were represented by a total of 15 speakers.

The program has attracted considerable interest, and to quote Professor Jenness:

"In my opinion the generous and active participation of so many industrial men in this educational venture is an accomplishment for which the Section can well be proud. It is the opinion of our students and staff that this program has been very valuable. Many favorable comments have come to my attention during the school year. It is recognized that companies that have supported this program have suffered some expense and inconvenience in providing us with lectures. Our administration is appreciative of this support and it is hoped that the investment in these young men will prove to be a good one."

The following tabulation shows the names of speakers in each course, and the topics discussed.

PULP TECHNOLOGY

Chemical Properties of Pulp Wood—Professor Fay Hyland, University of Maine, Orono, Me.
Preparation of Pulp Wood—C. A. Redden, Hollingsworth & Whitney Co., Waterville, Me.
Mechanical Pulping—Robert Nivison, Jr., Hollingsworth & Whitney Co., Waterville, Me.
Sulphite Acid Preparation—E. R. Barker, Hollingsworth & Whitney Co., Waterville, Me.
Sulphur Dioxide Recovery—A. H. Lundberg, G. D. Jennsen Co., Watertown, N. Y.
Sulphite Pulping—J. G. L. Caulfield, The Eastern Corporation, South Brewer, Me.
Caustic Pulping—Dr. T. H. Werner, S. D. Warren Co., Cumberland Mills, Me.
Sulphite Semi-Chemical Pulping—Henry Perry, Consulting Chemical Engineer, New York City
Kraft Pulping—T. J. Carlin, Northern Kraft Division, Gilman Paper Co., Howland, Me.
Soda Pulping and Chemical Recovery—E. W. Keith and John Darrah, Penobscot Chemical Fibre Co., Great Works, Me.

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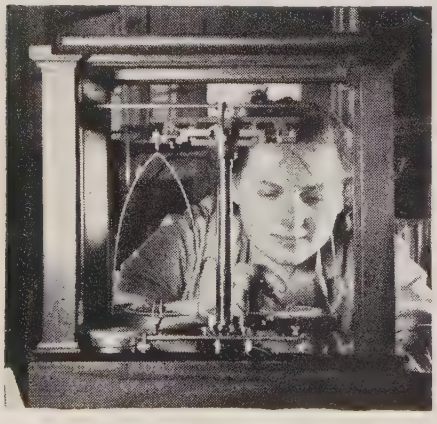

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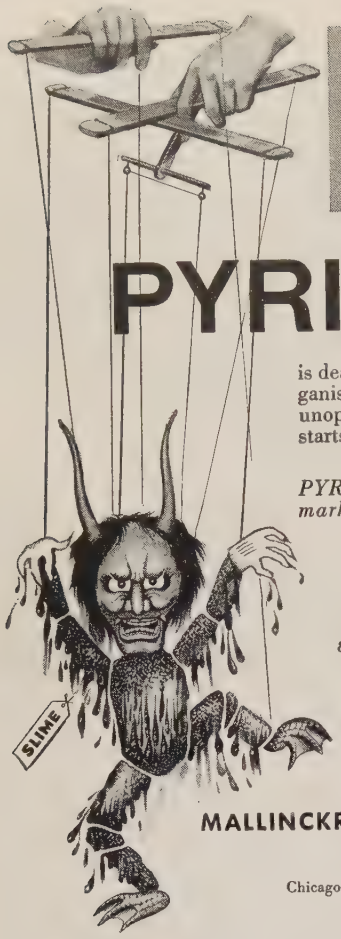

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(continued from page 66 A)

Heat and Chemical Recovery—Frank Roberts, S. D. Warren Co., Cumberland Mills, Me.
Peroxide Bleach—L. A. Pierce, St. Regis Paper Co., Bucksport, Me.
Chlorine Bleach Preparation—N. R. Phillips, Hollingsworth & Whitney Co., Waterville, Me.
Bleach Systems, Single and Multistage—Dr. John L. Parsons, Hollingsworth & Whitney Co., Waterville, Me.
Personnel Management—E. B. Stevens, Hollingsworth & Whitney Co., Waterville, Me.

Paper Technology

Stock Preparation—Beaters and Refiners—F. B. Schelhorn, Brown Co., Berlin, N. H.
Sizing—John Turbyne, Hollingsworth & Whitney Co., Waterville, Me.
Loading and Fillers—Olin W. Callighan, Edgar Brothers Clay Co., Kalamazoo, Mich.
Coloring—F. A. Soderberg, General Dyestuff Corp., New York, N. Y.
Paper Machines—Wet End, Sheet Formation—A. M. Lund, Hudson Pulp and Paper Co., Augusta, Me.
Coating—Dr. F. H. Frost, S. D. Warren Co., Cumberland Mills, Me.
Finishing and Converting—Robert A. Bancroft, Hollingsworth & Whitney Co., Waterville, Me.
Coarse Papers—Board, Containers—C. S. Huestis, Robert Gair Co., Thames River Division, Uncasville, Conn.
Paper Machines—Pressing, Drying and Calendering—Warren F. Daniell, Great Northen Paper Co., Millinocket, Me.
Printing Papers and Printing Processes—Edward L. Lamb, Oxford Paper Co., Rumford, Me.; and A. P. Reynolds, S. D. Warren Co., Cumberland Mills, Me.
Paper Testing and Specifications—Dr. Edwin Sutermeister, S. D. Warren Co., Cumberland Mills, Me.

Pulp and Paper Mill Equipment

Pulp and Paper Mill Engineering—Max Getchell, The Eastern Corporation, South Brewer, Me.
Pumps and Pumping Problems—Parkman A. Collins, Parkman A. Collins Co., Boston, Mass.
Industrial Uses of Rubber—W. R. Folk, Goodyear Tire and Rubber Co., Portland, Me.
Power Generation and Distribution—Fred Stetson, The Eastern Corporation, South Brewer, Me.
Electric Motors and Starting Equipment—J. A. Stone, General Electric Co., Boston, Mass.
Ceramic Linings—E. F. Tucker, Stebbins Manufacturing Co., Watertown, N. Y.
Stock Preparation Equipment—C. B. Muzzy, E. D. Jones & Son Co., Pittsfield, Mass.
Conveying Equipment—John D. Riley, Link-Belt Co., Boston, Mass.
Paper Machines—Charles S. Adams, Rice Barton Corp., Worcester, Mass.
Stainless Steel—Anson B. Albree, Michigan Steel Casting Co., Detroit, Michigan.
Air Supply and Exhaust in Paper Mills—Charles R. Huntoon, C. J. Merrill, Inc., Portland, Me.
Automatic Control Application in the Pulp and Paper Mill—James M. McAlear, Mason-Neilan Regulator Co., Boston, Mass.
Wood Room Equipment—R. B. Everts, Allis-Chalmers Manufacturing Co., Boston, Mass.
Pump Theory and Practice—T. Davenport, Worthington Pump and Machinery Corp., Harrison, N. J.
Pulp Washing and Bleaching Equipment—John Rich, Improved Paper Machinery Corp., Nashua, N. H.

General

Clarke E. Snook, Chief Chemist, Paper Chemical Laboratory, NOPCO Chemical Co., writes: "I wish to express my appreciation for the fine coverage you are giving to the local section meetings. Most of us attend our local groups but are not in a position to share the excellent and very informative papers given at other section meetings held throughout the country. I like to be one who acknowledges the importance of the Local Section Activities Department in *Tappi*.

Ed. Note: Mr. Snook's comments are appreciated since they guide the editorial staff relative to the kind of information that readers of *Tappi* wish to have published.

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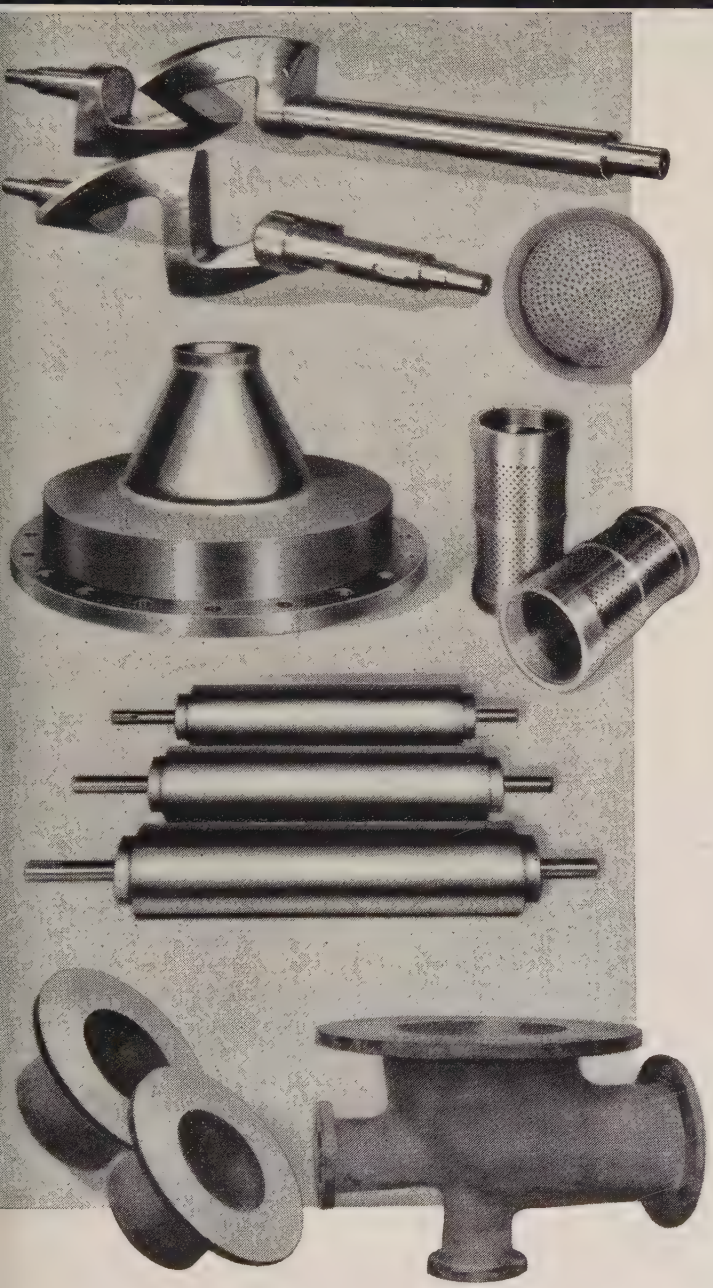

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TAPPI DIVISIONS AND COMMITTEES

Recent Reports of Activities

Engineering Division

The Engineering Division is probably the oldest in the Technical Association. The Association was organized to be an engineering organization and featured subjects in this field at its first meeting.

Although the Association did not have a divisional organization in its early years, it had a Heat, Light, and Power Committee that attempted to cover its engineering interests.

To meet a growing need for the consideration of engineering subjects the Division was reorganized in 1946 during the administration of G. W. E. Nicholson as President, with Edwin F. Burns, International Paper Co., as general chairman, and the First Engineering Conference of the Pulp and Paper Industry was held at Milwaukee. Following the death of Mr. Burns, J. W. Hemphill of the Johns-Manville Corp. became chairman and arranged the Second and Third Conferences at Philadelphia and Buffalo, respectively.

At present George H. Pringle, Asst. Chief Engineer of the Mead Corp., general chairman, and J. W. Hemphill, general secretary, are preparing the Fourth Engineering Conference which will be held at the Statler Hotel in Boston on Oct. 31 to Nov. 3, 1949.

Materials Handling Committee

The importance of materials handling as an engineering problem in the pulp and paper industry led to the establishment of a committee in the reorganized Engineering Division to deal with the subject.

George R. Wadleigh, a consulting engineer in New York City and formerly Chief Engineer of the West Virginia Pulp and Paper Co., became its first chairman and conducted a well-attended session at the Buffalo conference.

Associated with Mr. Wadleigh as members of the committee are:

S. L. Foster, Chief Engineer, Kalamazoo Vegetable & Parchment Co., Kalamazoo, Mich.
W. A. McKenzie, Director of Engineering, Simpson Logging Co., Shelton, Wash.
T. R. H. Murphy, Consulting Engineer, G. H. Mead Co., New York, N. Y.
K. C. Neuenfeldt, Mechanical Engineer, Hammermill Paper Co., Erie, Pa.
C. A. Redden, Chief Engineer, Hollingsworth & Whitney Co., Waterville, Me.

The members of the Advisory Sub-committee include:

L. A. Johnson, Soundview Pulp Co., Everett, Wash.
H. F. R. Webber, Link Belt Co., Chicago, Ill.

The committee is engaged in preparing a fine program for the Boston Engineering Conference and Mr. Wadleigh is preparing the chapters on materials handling for the new textbooks on Pulp and Paper Manufacture.

Drying and Ventilating Committee

The Drying and Ventilating Committee has been active in the Association for many years under the excellent chairmanship of A. E. Montgomery, Vice-President of the J. O. Ross Engineering Co. in Chicago, Ill.

Associated with Mr. Montgomery as members of the committee are:

R. H. Doughty, Research Director, Fitchburg Paper Co., Fitchburg, Mass.
E. G. Drew, Drew Engineering Co., Portland, Ore.
J. C. Nutter, John Inglis Co., Ltd., Toronto, Ont.
W. J. O'Brien, O'Brien Steam Specialty Co., Syracuse, N. Y.
G. L. Snyder, Lukens Steel Co., Coatesville, Pa.
F. C. Stamm, Stamm Drying Controls, Lockport, N. Y.
C. A. Young, Mechanical Engineer, West Virginia Pulp and Paper Co., Charleston, S. C.
G. H. Young, Midwest-Fulton Machine Co., Dayton, Ohio

The committee has two long-term projects: No. 66—Variation of Drying Rates of Individual Driers Through the Drier Section and No. 117—Monograph on the Drying of Pulp, Paper, and Paperboard on the Paper Machine. The latter project is based on field studies made by an engineer employed by the Technical Association.

The committee is planning a program for the Boston Engineering Conference which will deal with dust collection or filtration for paper mills. Consideration will be given to types of air filters, their uses, maintenance, etc. An effort will be made to show the first cost and maintenance costs to give relative over-all costs of operating the different kinds of filters. This subject should have considerable appeal to papermill engineers since there is a general lack of understanding of the limitations of the several types of filters.

Mill Design and Economic Aspects Committee

Alvin H. Johnson, Consulting Engineer, New York, N. Y., succeeded Milton Jacobs of Chas. T. Main, Inc., as chairman of the Mill Design and Economic Aspects Committee. Associated with Mr. Johnson as committeemen are the following:

A. N. Ball, Chief Engineer, E. B. Eddy Co., Hull, P. Q.
Geo. C. Ehemann, Jr., Plant Engineer, The Ohio Boxboard Co., Rittman, Ohio.
S. H. Grimnes, Chief Engineer, B-F-D Div., The Diamond Match Co., Plattsburg, N. Y.

The following are members of the Advisory Sub-committee:

H. T. Baker, Consulting Engineer, H. K. Ferguson Co., Cleveland, Ohio.
S. L. Foster, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.
M. J. Goloff, St. Regis Paper Co., Kalamazoo, Mich.
M. W. Heddon, Chemical Engineer, Racquette River Paper Co., Potsdam, N. Y.
J. H. McCarthy, Chief Engineer, St. Regis Paper Co., Kraft Pulp Div., Tacoma, Wash.
Carl Magnus, Superintendent, Moraine Paper Co., W. Carrollton, Ohio.
E. C. Nelson, Engineer, Gilbert Paper Co., Menasha, Wis.

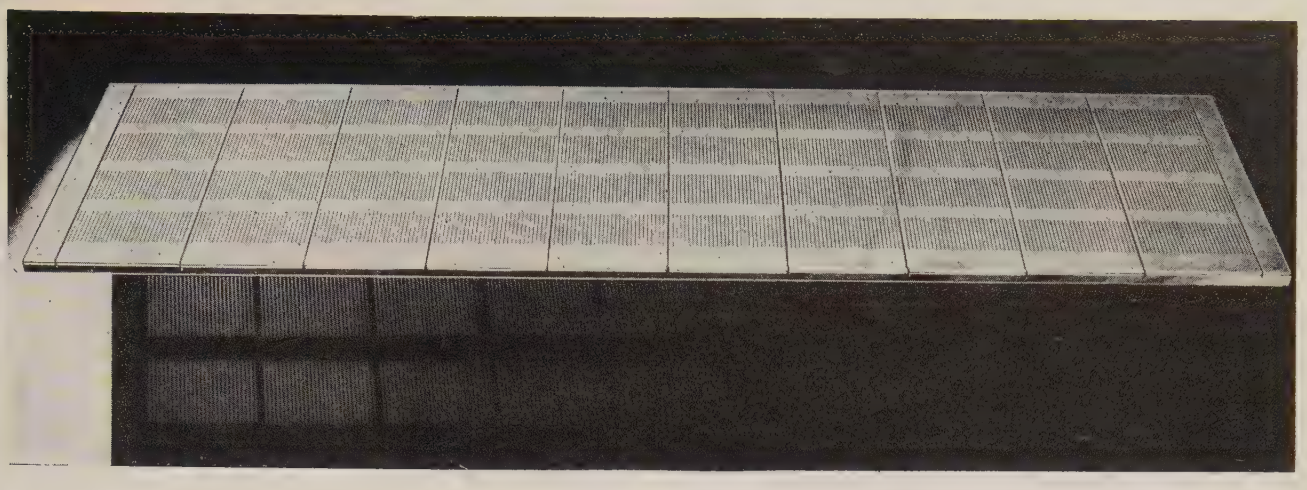
The committee is organizing a program for the Fourth Engineering Conference. This will include a consideration of the merits of various types of paper machine drives and the design of mill buildings.

Steam and Power Committee

The Steam and Power Committee succeeded the old Heat, Light, and Power Committee which existed almost from the time of the founding of the Association. The first chairman of the reorganized committee was J. E. A. Warner, Chief Engineer of the Robert Gair Co., New York, N. Y. Mr. Warner prepared the fine programs of the Milwaukee, Philadelphia, and Buffalo Conferences.

In February of this year he was succeeded as chairman

(*continued on page 72 A*)



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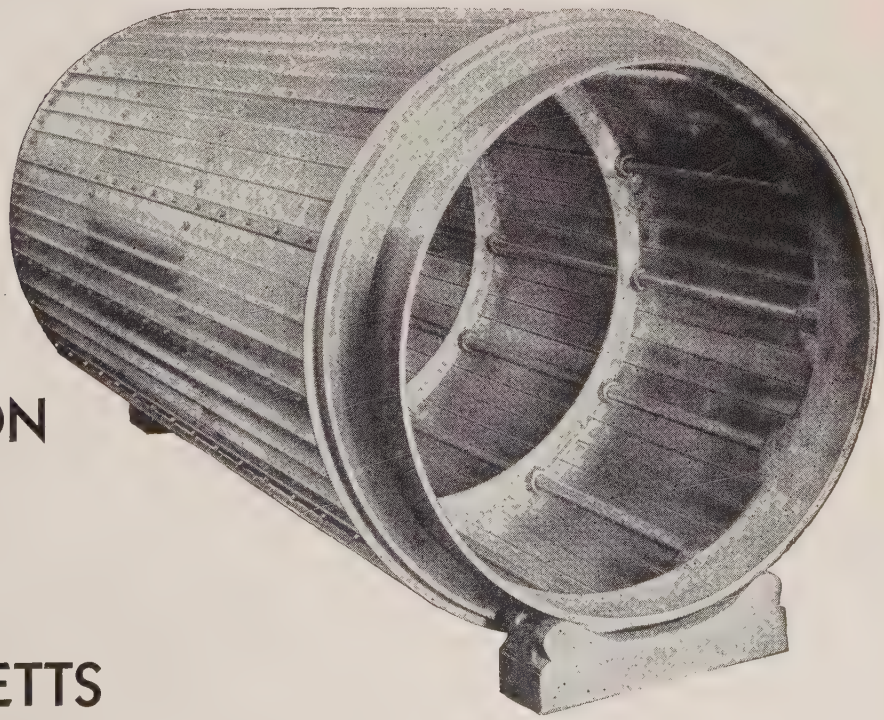

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by C. J. Sibler, Chief Engineer of the West Virginia Pulp and Paper Co., New York, N. Y. To assist Mr. Sibler, W. C. Bloomquist of the General Electric Co., Schenectady, N. Y., is secretary of the committee. The practice of having committee secretaries is new and has many advantages. Because of the wide area served by the Association committees it is difficult to hold meetings except during national conventions. In most cases it is almost impossible for chairmen to keep in touch with committeemen except through correspondence. In the case of Messrs. Bloomquist, Hemphill, and other secretaries in the Engineering Division it is possible to maintain much of the necessary contacts since they have occasion to visist a number of mills during the year.

Associated with Messrs. Sibler and Bloomquist as members of the Steam and Power Committee are the following:

Marvin H. Dixon, Power Engineer, St. Regis Paper Co., Deferiet, N. Y.
Walter H. Hall, Engineer, The Mead Corp., Chillicothe, Ohio
W. J. Schnaufer, Chief Engineer, Detroit Sulphite Pulp and Paper Co., Detroit, Mich.
W. J. Sprau, Plant Engineer, National Gypsum Co., Kalamazoo, Mich.
B. M. Turner, Chief Engineer, International Paper Co., New York, N. Y.
J. E. A. Warner, Chief Engineer, Robert Gair Co., New York, N. Y.
W. M. Wyburn, Engineer, Federal Paper Board Co., Bogota, N. J.

The members of the Advisory Subcommittee include:

H. R. Arnold, Power Engineer, Union Bag & Paper Corp., Savannah, Ga.
F. E. Hutton, Babcock & Wilcox Co., New York, N. Y.
H. D. Nickle, Combustion Engineering-Superheater, Inc., New York, N. Y.

At present the Steam and Power Committee docket includes two long-range projects: No. 174—Study of Fuels and Their Application and No. 215—Methods of Power Plant Cost Accounting. The immediate objective of the committee is the preparation of its part of the program of the Fourth Engineering Conference.

Chemical Engineering

James R. Lientz, General Superintendent, Pulp and Paper Division, Union Bag & Paper Corp., Savannah, Ga., has been appointed Chairman of the Chemical Engineering Committee.

This committee was recently transferred from the Research Development Division to the Engineering Division and is in process of being completely reorganized.

Members of the Association who are interested primarily in chemical engineering, as such, particularly in the unit processes and would like to serve on this committee should advise Mr. Lientz or the Secretary of the Association. Since this committee will function hereafter in the Engineering Division its scope will deal with the subject purely on an engineering basis.

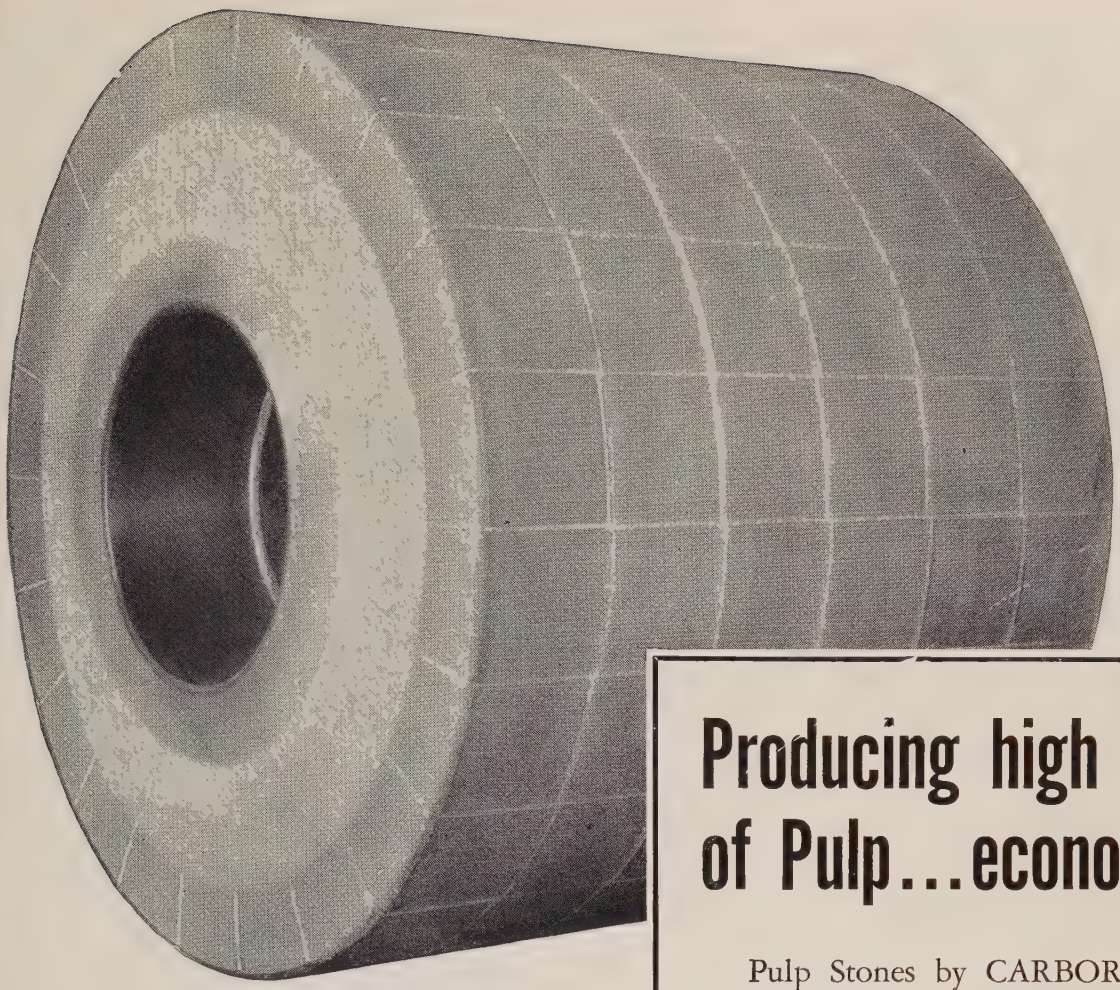
Electrical Engineering Committee

Because of the broad scope of electrical engineering in the pulp and paper industry it was decided to establish a separate committee apart from the Steam and Power Committee to deal with this branch of engineering. Its scope will embrace electrical distribution and application.

A. C. Goodrich, Chief Engineer of the Hammermill Paper Co., Erie, Pa., has been appointed Chairman and G. W. Knapp, Engineer, General Electric Co., Schenectady, N. Y., will serve as the committee secretary. Associated with Messrs. Goodrich and Knapp are:

R. R. Baker, Westinghouse Electric Corp., E. Pittsburgh, Pa.
E. L. Cowan, Asst. Chief Engineer, Gaylord Container Corp., Bogalusa, La.

(*continued on page 74 A*)



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(continued from page 72 A)

J. L. Van Nort, Reliance Electric & Engineering Co., Cleveland, Ohio

Members of the Advisory Sub-committee include:

F. L. Davis, West Virginia Pulp & Paper Co., Luke, Md.
C. S. Leaf, Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Ray Foster, Champion Paper & Fibre Co., Canton, N. C.

The scope of the committee includes all electrical equipment and problems starting with the generator leads in the power house, through the distribution system, including utilization.

The purpose of the committee is to assist the pulp and paper industry in obtaining the best electrical equipment possible for the solution of its problems.

To get the Electrical Engineering Committee off to a flying start it was decided to choose subjects for 1949 which had already been investigated, and where there was a need for report, discussion, and recommendations. The problem of power requirements and starting-torque requirements for paper machine drives met these conditions very well. These results will be reported later by Mr. Goodrich and will cover Fourdrinier machines (except tissue), tissue machines, and cylinder machines.

Plans for the Fourth Engineering Conference are being completed. The committee plans to present two papers:

First Report on Committee Project: "Power Requirements for Paper Machines," by A. S. Goodrich, Chairman, Electrical Engineering Committee.
"Electrification of a Pulp and Paper Mill," by J. C. Lynch, Electrical Engineer, Hammermill Paper Co., Erie, Pa.

Engineering Data Sheets Committee

For several years the Association has been issuing data sheets of a miscellaneous nature. Recent checkups have indicated that these sheets are being used and well thought of. The Association started to issue these sheets after noting a similar service being offered by the Technical Section of the Canadian Pulp and Paper Association.

From time to time, members have suggested the desirability of having a Pulp and Paper Manufacture and Engineering Handbook similar to publications serving other fields. It was with this idea in mind that the Data Sheets service was started. It was felt that since no one felt agreeable to undertaking the preparation of such a handbook, the Association, through its membership, could approach such an objective by easy but steady stages. Since there have been but few voluntary contributions by members to this service most of the sheets have been prepared by the Association headquarters staff.

The need for more rapid and more extensive accumulation of Data Sheets has been noted by the Engineering Division and a step to that end was made recently in the appointment of an Engineering Data Sheets Committee. Henry J. Perry, Consulting Engineer, 12 N. Hillside Ave., Chatham, N. J., agreed to accept the chairmanship and now has associated with him as committeemen:

J. F. T. Berliner, Consulting Engineer, Chicago, Ill.
G. H. Chidester, Chief, Pulp and Paper Section, Forest Products Laboratory, Madison, Wis.
M. H. Dixon, Chief Engineer, St. Regis Paper Co., Deferiet, N. Y.
S. L. Foster, Chief Engineer, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.
C. L. Knowles, Knowles Associates, New York, N. Y.
W. R. McKelvy, Engineer, Patchogue-Plymouth Mills, Patchogue, N. Y.

The committee will need the help of a large number of members of the Association. All members have received mailings of the Data Sheets and are familiar with their form and contents. A real opportunity is therefore provided for each member to share his knowledge and thereby not only encourage the committee but help build up a collection of data sheets that will be of considerable value. It should be kept in mind that an Association such as TAPPI depends on voluntary assistance from every member. It differs from a service bureau which depends mostly upon the efforts of a central research staff.

Aside from furnishing data sheets the committee is interested in receiving comments regarding the Data Sheets Service, such as: What type of data should be included? Should it be specific to the industry or be more general? To what extent should the data submitted be reviewed and approved for publication? Comments may be sent to Mr. Perry or to the Technical Association.

Mill Maintenance and Materials Committee

The Mill Maintenance and Materials Committee has been active in the Association for several years. It was originally established as a Waste Committee and by evolution became, in sequence, the Waste and Corrosion Committee, Materials of Construction Committee, and just prior to the First Engineering Conference it adopted its present title with G. H. Pringle as chairman.

When Mr. Pringle became general chairman of the Engineering Division this year, Wm. McIntosh, Jr., of the Union Bag & Paper Corp., and now of the Southern Corp., became chairman. The Committee has taken a vital part in all of the Engineering Conferences particularly in the field of preventive maintenance and lubrication. In both of these fields the Committee is carrying on a long-range program which will eventually produce some useful data sheets and recommended practices.

(continued on page 76 A)

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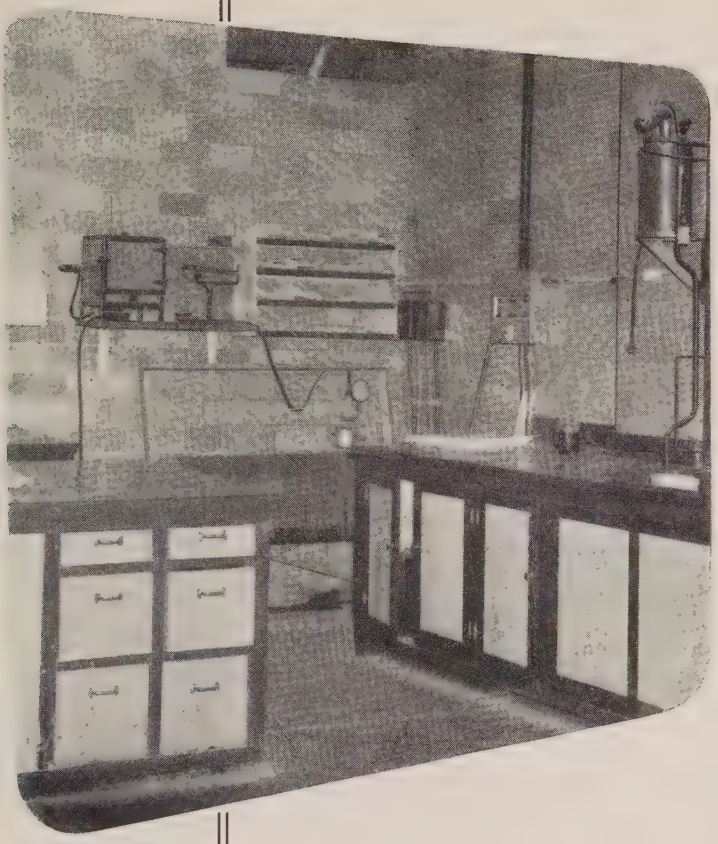

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As presently constituted the personnel of the Committee includes:

Wm. McIntosh, Jr., Southern Corp., Savannah, Ga., *Chairman*
P. B. Corning, Chief Engineer, Rayonier, Inc., Fernandina, Fla.
K. H. Fleming, Asst. Chief Engineer, Hammermill Paper Co., Erie, Pa.
S. L. Foster, Chief Engineer, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.
G. F. Hrubecky, Supervisor of Mechanical Maintenance, Marathon Corp., Menasha, Wis.
C. G. R. Johnson, Asst. Chief Engineer, Kimberly-Clark Corp., Neenah, Wis.
W. P. Nesbitt, Mechanical Superintendent, Howard Smith Paper Mills, Cornwall, Ont.
H. F. Parker, Maintenance Engineer, New York & Pennsylvania Co., Lock Haven, Pa.
H. P. Petzold, Plant Engineer, Oxford-Miami Paper Co., W. Carrollton, Ohio
G. H. Pringle, Asst. Chief Engineer, Mead Corp., Chillicothe, Ohio
F. W. Roberts, Asst. Chief Engineer, S. D. Warren Co., Cumberland Mills, Me.

Associated with this Committee is an Advisory Subcommittee as follows:

R. T. Barnes, International Nickel Co., New York, N. Y.
H. J. Bartlett, Crane Co., Chicago, Ill.
H. H. Burrows, Raybestos-Manhattan, Inc., Passaic, N. J.
G. W. Charters, Crown Zellerbach Corp., Camas, Wash.
A. M. Cooper, Westinghouse Electric Corp., E. Pittsburgh, Pa.
C. D. Cummings, SKF, Inc., Philadelphia, Pa.
C. M. De Mers, Taylor Instrument Cos., Rochester, N. Y.
J. W. Hemphill, Johns-Manville Corp., New York, N. Y.
F. E. Hutton, Babcock & Wilcox Co., New York, N. Y.
R. S. Johnston, Pusey & Jones Corp., Wilmington, Del.
H. C. Moore, Beloit Iron Works, Beloit, Wis.
V. P. Owens, Combustion Engineering-Superheater, Inc., New York, N. Y.
R. K. Prince, Allis-Chalmers Mfg. Co., Milwaukee, Wis.
A. I. Sippola, Socony-Vacuum Oil Co., New York, N. Y.
J. L. Van Nort, Reliance Electric & Engineering Co., Cleveland, Ohio
H. F. R. Weber, Link-Belt Co., Chicago, Ill.

Engineering Research and Machine Design Committee

The Engineering Research Committe was originally established in the Research Development Division to be a medium for considering fundamental research problems of a mechanical nature. Its first chairman was J. B. Gough, now Chief Engineer of the Mead Corp. He was later succeeded by W. G. MacNaughton (deceased), Engineer of the News Print Service Bureau. In 1948 the scope of the Committee was broadened to include basic machine design and this feature was added to the name of the Committee.

The personnel of the Committee includes:

P. H. Goldsmith, Engineer, Pusey & Jones Corp., Wilmington, Del., *Chairman*
R. R. Baker, Engineer, Westinghouse Electric Corp., E. Pittsburgh, Pa.
R. C. Berger, Engineer, General Electric Co., Schenectady, N. Y.
A. L. M. Bixler, Chemical Engineer, Riegel Paper Corp., Milford, N. J.
F. O. Boylon, Mill Manager, Fernstrom Paper Mills, Pomona, Calif.
C. W. Cassell, Technical Director, John Strange Paper Co., Menasha, Wis.
J. W. Crocker, Supervisor of Engineering, Sandy Hill Iron & Brass Works, Hudson Falls, N. Y.
R. T. De Pan, Development Engineer, Downingtown Mfg. Co., Downingtown, Pa.
Lloyd Ewing, Engineer, Ewing Engineering Co., Milwaukee, Wis.
H. G. Ingraham, Engineer, Bird Machine Co., S. Walpole, Mass.
J. D. Lyall, Project Engineer, Armstrong Cork Co., Lancaster, Pa.
C. E. Macklem, Engineer, Beloit Iron Works, Beloit, Wis.
Floyd Nienow, Chief Engineer, Ward Paper Co., Merrill, Wis.
R. G. Quinn, Chemical Engineer, Johns-Manville Corp., Manville, N. J.

One of the first projects to attract the attention of this committee was the study of the friction drop in the flow of pulp or paper stock in pipes. So many other considerations are dependent on the establishment of authoritative flow friction curves that a solution of this problem appeared to be of first importance. The interest in the subject displayed at the Third Engineering Conference at Buffalo last fall led to the establishment of a Hydraulics Sub-committee.

The personnel of the Hydraulics Sub-committee is as follows:

K. J. MacKenzie, Superintendent of Paper Mill, Eastman Kodak Co., Rochester, N. Y., *Chairman*
Tany Agronin, Shartle Bros. Machine Co., Middletown, Ohio
W. B. Eklund, Warren Steam Pump Co., Warren, Mass.
B. W. Ellis, Buffalo Pumps, Inc., N. Tonawanda, N. Y.
C. L. Forshee, Goulds Pumps, Inc., Seneca Falls, N. Y.
W. Gallay, E. B. Eddy Co., Hull, P. Q.
V. De P. Gerbereux, Worthington Pump & Machy. Co., Harrison, N. J.
J. H. Hall, De Laval Steam Turbine Co., Trenton, N. J.
G. R. Hargis, Frederick Iron & Steel Co., Frederick, Md.
L. C. Jenness, University of Maine, Orono, Me.
H. Wyatt Johnston, Sutherland Refiner, Ltd., Montreal, P. Q.
H. K. Kingsbury, Allis-Chalmers Mfg. Co., Milwaukee, Wis.
S. G. Mason, McGill University, Montreal, P. Q.
R. C. McCully, International Paper Co., Niagara Falls, N. Y.
F. W. O'Neil, New York State College of Forestry, Syracuse, N. Y.
W. H. Pfarrer, Morris Machine Works, Baldwinsville, N. Y.
R. G. Quinn, Johns-Manville Corp., Manville, N. J.
G. V. Shaw, Ingersoll-Rand Co., New York, N. Y.
L. G. Vande Bogart, Crane Co., Chicago, Ill.
J. A. Van den Akker, Institute of Paper Chemistry, Appleton, Wis.

PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Owen C. Abbott, Application Engineer, The Bristol Co., Waterbury, Conn., a 1929 graduate of Tri-State College.

Carl H. Allendorf, Project Engineer, The Philip Carey Mfg. Co., Lockland, Ohio, a 1936 graduate of the University of Cincinnati.

Howard J. Angstadt, Chemist, Keasbey & Mattison, Ambler, Pa., a 1936 graduate of Temple University.

Brian Barber, Chief Chemist, The Inveresk Paper Co., Ltd., Musselburgh, Scotland.

Harry C. Bauer, Director of Libraries, University of Washington, Seattle, Wash., a 1927 graduate of the University of Washington, with an M.S. degree in 1929.

Maurice H. Bigelow, Technical Director, Plaskon Div., Libbey-Owens-Ford Glass Co., Toledo, Ohio, a 1924 graduate of Northeastern College, with a Ph.D. degree from the University of Pittsburgh.

Henry A. Birdsall, Technical Div., Bell Telephone Laboratories, Inc., New York, N. Y., a 1940 graduate of Columbia University.

Lewis C. Branscomb, Assistant Director of Libraries, Ohio State University, Columbus, Ohio.

Kenneth W. Brenner, Project Engineer, Eastman Kodak Co., Rochester, N. Y., a 1929 graduate of the University of Pennsylvania.

J. Walter Couture, Chief Engineer, Dilts Machine Works, Fulton, N. Y.

Cliff R. Crawford, Vice-President, Shartle Bros. Machine Co., Middletown, Ohio.

Robert R. Crawford, Sales Engineer, Shartle Bros. Machine Co., Middletown, Ohio, a 1935 graduate of Ohio University.

Stephen R. H. Edge, Head of Technical Information Office, Wiggins Teape & Co., London, England, a 1914 graduate of Gonvilles Caius, Cambridge, with an M.A. degree in 1920.

H. Scott Eagleson, Coating Superintendent, Escanaba Paper Co., Escanaba, Mich., a graduate of Muskingum College.

James H. Galloway, Chemist, Riegel Paper Corp., Milford, N. J., a 1949 graduate of the University of Alabama.

Charles E. Gehr, Student, New York State College of Forestry, Syracuse, N. Y.

Lester D. Grady, Jr., Chief, Special Applications Section, Technical Dept., The New Jersey Zinc Co. (of Pa.), Palmerton, Pa., a 1928 graduate of Lehigh University.

John D. Hetherinton, Plant Engineer, Universal Box Co. Ltd., Vancouver, B. C., Canada, a 1945 graduate of the University of British Columbia.

Ching-yuin Hsu, Graduate Student, University of Maine, Orono, Me., a 1945 graduate of the University of Nanking (China).

Charles R. Kise, Manager, Economy Pumps, Inc., Philadelphia, Pa., a 1931 graduate of Antioch College.

Nellie G. Larson, Librarian, U. S. Dept. of Agriculture, Northern Regional Research Laboratory, Peoria. Ill.

Jack McKela, Sales Engineer, Dilts Machine Works, Fulton, N. Y., a 1947 graduate of the New York State College of Forestry.

Robert F. Lynch, Assistant Paper Chemist, St. Regis Paper Co., Tacoma, Wash., a 1948 graduate of New York State College of Forestry.

Wylie B. Mendel, Plant Engineer and Assistant Superintendent, S. George Co., Wellsburg, W. Va., a 1940 graduate of West Virginia University.

Karl R. Meyer, Development Engineer, E. B. Eddy Co., Hull, P. Q., Canada, a 1937 graduate of the University of London (England).

Aaron Miller, Research Chemist, Kelco Co., San Diego, Calif., a 1942 graduate of the University of Iowa with a Ph.D. degree.

Charles S. Morton, Jr., Paper Tester, Doubleday & Co., Garden City, L. I., N. Y., a 1947 graduate of Massachusetts Institute of Technology.

Edward K. Nissen, Student, New York State College of Forestry, Syracuse, N. Y.

Corrado Nodari, Technical Director of Paper Mill, S. A. La Fibra Vulcanizzata & Cartiere Prealpine, Milano, Italy, a 1946 graduate of the Polytechnic University of Milano with a Ph.D. degree.

Robert Peteri, Chief of Research Service, Regie Industrielle de la Cellulose Coloniale, Paris, France, a 1947 graduate of Ecole Francaise de Papeterie with a Ph.D. degree.

Walter A. R. Pertuch, Librarian, The Franklin Institute, Philadelphia, Pa.

H. T. Pledge, Keeper, Science Library, Science Museum, London, England.

Jorge Roldan, Chemist, Cia. Industrial de Atenquique, S. A., Atenquique, Jal., Mexico, a 1948 graduate of Universidad Nacional Autonoma de Mexico.

Robert H. Simonds, Head of Order Dept., Minneapolis Public Library, Minneapolis, Minn.

Richard J. Sorenson, Electrical Engineer, Union Bag & E. Sirrine Co., Greenville, S. C. Attended Columbia University of Minnesota.

Churchill J. Thompson, Mechanical Design Engineer, J. E. Sirrine Co., Greenville, S. C. Attended Columbia University.

Fletcher P. Thornton, Jr., Sales Engineer, Stowe-Woodward, Inc., New York, N. Y., a 1936 graduate of Massachusetts Institute of Technology.

Malcolm H. Tinker, Manager, Mullen Tester Div., B. F. Perkins & Sons, Holyoke, Mass., a 1933 graduate of U. S. Naval Academy.

Jack H. Waggoner, Technical Assistant to Executive Vice-President, Owens-Corning Fiberglas Corp., Toledo, Ohio, a 1920 graduate of the University of Kansas.

Herbert H. Weber, General Manager, H. G. Weber & Co., Inc., Kiel, Wis., a 1929 graduate of Lawrence College.

Lloyd M. Welker, Raw Material Engineer, Western Electric Co., Inc., Chicago, Ill., a 1937 graduate of Iowa State College.

Robert Williams, Periodical Librarian, Michigan State College Library, E. Lansing, Mich., a 1941 graduate of Syracuse University.

TAPPI Notes

Harold C. Burrill, formerly of Burrill & Givin, is now with Harold G. Burrill & Associates, Registered Professional Engineers, 11 E. 21st St., Baltimore 18, Md.

Warren A. Chilson, formerly of the Nothern Paper Mills, is now sales manager, Curlator Co., Rochester, N. Y.

(*continued on page 78 A*)

J. D. Dailey, formerly of Brompton Pulp & Paper Co., Ltd., is now sulphate superintendent, Coosa River Newsprint Mill, Coosa Pines, Ala.

Alfred de Ropp, Jr., is now manager of sodium sulphate sales, American Potash & Chemical Corp., 122 E. 42nd St., New York 17, N. Y.

F. D. Elliott, formerly of the Graphic Arts Research Laboratory, is now research chemist, Springdale Laboratories, Springdale, Conn.

Herbert F. Gardner, formerly of the Stein-Hall Co., is now on the research staff, Pabst Brewing Co., Milwaukee, Wis.

John H. Gillies, formerly of General Aniline & Chemical Corp., is now process engineer for Foster Wheeler Corp., Dansville, N. Y.

F. J. Gleason, formerly of Bird & Son, is now with Ware Laboratory, Inc., Miami, Fla.

Walter L. Hardy, formerly of Shellmar Products Corp., is now sales manager, Eastern Div., Floyd A. Holes Co., mfgrs. of packaging materials, New York, N. Y.

Alfred W. Hopton, formerly of the Hooker Electrochemical Co., is now director of the Niagara Industrial Laboratories, Niagara Falls, N. Y.

Ralph G. Johnstone, formerly of E. B. Eddy Co., Ltd., is now asst. to the production manager, Brompton Pulp and Paper Co., E. Angus, P. Q.

Francis R. Loetterle of National Starch Products, Inc., has been transferred from Chicago, Ill., to San Francisco, Calif.

Joseph V. Mason, formerly of the Granville Paper Co., is now with the Jelks Machine Co., Miamisburg, Ohio.

Glenn W. McKnight, formerly of Time, Inc., is now with the Champion Paper & Fibre Co., Hamilton, Ohio.

Harold R. Murdock, formerly of the Natural Resources Section, G.H.Q. SCAP, Toyko, Japan, is now a consulting engineer with Robert & Co. Associates, Inc., 96 Poplar St., N. W., Atlanta, Ga.

Philip E. Nethercut, formerly student at The Institute of Paper Chemistry, is now chemist, Watervliet Paper Co., Watervliet, Mich.

J. V. Otness, of the Minnesota & Ontario Paper Co., has been transferred from Minneapolis to Chicago, Ill., where he is manager of the sales office.

Clifford B. Pape, Technical Director of Dominion Foils (Canada) Ltd., has been transferred from Montreal to Three Rivers, P. Q.

George W. Porter, formerly of the Technical Supply Co., is now patent attorney, Pillsbury Mills, Minneapolis, Minn.

James W. Purdy, formerly of British Columbia Pulp and Paper Co., Ltd., is now laboratory control engineer, Kraft Pulp Div., Abitibi Power & Paper Co., Ltd., Thunder Bay Div., Port Arthur, Ont.

L. V. Subba Rao, formerly of the University of Alabama, is now with the Sandy Hill Iron & Brass Works, Hudson Falls, N. Y.

Fred W. Sanders, formerly of National Starch Products, Inc., is now technical representative, Industrial Products Dept., Pillsbury Mills, Inc., Minneapolis, Minn.

Russell H. Savage is now Vice-President in charge of Research and Development, Mead Corp., Chillicothe, Ohio.

Ulf Soderlund, formerly of the New York State College of Forestry, is now asst. paper mill superintendent, Holmens Bruks & Fabriks A/B, Hallstavik, Sweden.

W. R. Tutton, research chemist, American Can Co., Ltd., has been transferred from Hamilton, Ont., to Vancouver, B. C.

Kurt Wandel, consulting engineer, formerly of Honey Brook, Pa., is now located at Downingtown, Pa.

Harry Weston, Assoc. Secretary-Treasurer, American Pulp and Paper Mill Superintendents Association, is now located at 111 W. Washington St., Chicago, Ill.

Dan B. Wicker, formerly with the American Viscose Co., is now in the Technical Service and Development Div., American Cyanamid Co., Stamford, Conn.

William E. Van Voorhis, Saugerties, N. Y., was elected by the senior and graduate students of pulp and paper technology at the University of Maine to have his name inscribed on the Paul D. Bray Memorial Plaque. This plaque was donated to the University in 1948 by students majoring in pulp and paper technology in memory of the late Paul D. Bray, formerly head of the Pulp and Paper Department.

* * *

Some of the visitors from overseas to the TAPPI office in New York were:

Adam B. Bendix, General Manager, United Paper Mills, Ltd., Copenhagen, Denmark.

Pierre Bersano, Plant Manager, Cartiere Burgo, Torino, Italy.

A. E. Rayner, John Dickinson & Co., Ltd., Watford, Herts, England.

William R. M. Watson, Managing Director, R. & W. Watson, Ltd., Renfrewshire, Scotland.

Th. Wegelius, Professor of Forest Technology, University of Helsinki, Finland.

* * *

Several companies have become corporate members of the Technical Association since the beginning of the year. These include:

Cartiera F. A. Marsoni, Venice, Italy
Crane & Co., Dalton, Mass.
Mosinee Paper Mills, Mosinee, Wis.
A. Ahlstrom O/S, Warkaus, Finland
Hollingsworth & Vose, E. Walpole, Mass.
Direccion General de Suministros Del Estado, Buenos Aires, Argentina
Netherlands Experiment Sta. for Utilization of Straw, Groningen, The Netherlands
Hugh Stevenson, Ltd., London, England
S. A. Forest Investments, Ltd., Johannesburg, Union of South Africa
Gujarat Paper Mills, Ltd., Ahmedabad, India
A/S Borregaard, Sarpsborg, Norway
A/S Follum Fabrikker, Honefoss, Norway

* * *

There are occasional requests for back issues of Technical Association Papers. If any member or company has no further use for these volumes the Technical Association would like to obtain them so that they may be given to those who have requested back issues.

* * *

Although it is a little late to report this event we have been urged to place on record the fact that H. L. Vanderberg, of A. E. Staley Co., made a "hole-in-one" at the Ridgemoor Golf Club, Grand Rapids, Mich., during the recent TAPPI Coating Conference. This deed was accomplished on the 225-yard, par 4, 17th hole. Included in the foursome were Bob Larson, St. Regis Paper Co., Carl Gehring, R. E. Kilty, and H. L. Vanderberg, all of Staley.

Industry Notes

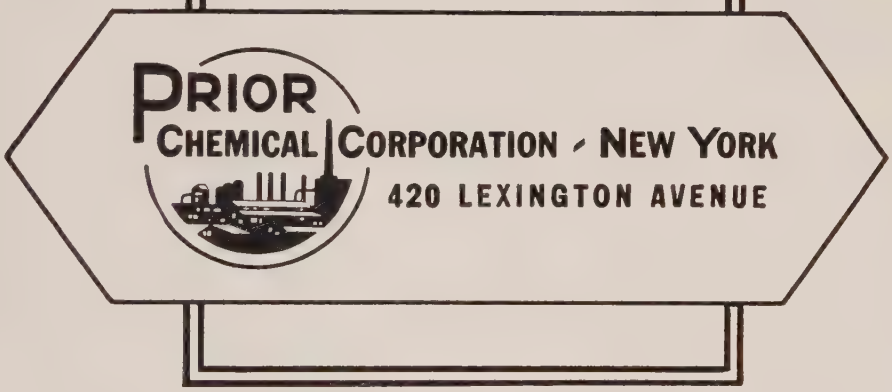
Charles A. Southwick, Jr., advises that he is now associated with Package Materials Laboratories, Hope, N. J. This firm is engaged in the manufacturing and selling of the following test apparatus: General Foods type water vapor transmission units; Elder type gas transmission apparatus; and temperature and humidity controlled atmosphere cabinets.

* * *

The American Cyanamid Co. has appointed C. F. Bonnet as production manager of its Industrial Chemical Division, and G. W. Russel as assistant sales manager of the same division.

(continued on page 80 A)

SALT CAKE



High quality, free-flowing material available for shipment by rail or water to the paper industry from strategically located points.

Harold D. Skyrm was recently elected Vice-President of the General American Transportation Corp., Chicago, Ill. Mr. Skyrm was recently made head of the Process Equipment Plate and Welding and Wiggins Vapor Seals Divisions.

* * *

E. C. Jahn, Professor of Forest Chemistry, has recently been appointed Director of Research at the New York State College of Forestry, Syracuse, N. Y. The research program is currently budgeted at $225,000. Laboratory and field investigations now under way at the college include methods of pulping hardwoods, improved manufacture of plywood by electronic heating, decay resistance and prevention in wood, control of wood-destroying insects in New York, and regeneration of abandoned land through forest management.

* * *

Heppenstall Co., Hatfield St., Pittsburgh 1, Pa., has issued a metallurgical book "Tensile Steel." (Obtainable at $3.00 per copy.)

* * *

The Pusey & Jones Corp. has been awarded the contract for a 226-inch Fourdrinier machine for the first newsprint mill in India. The National Newsprint and Paper Mills, Ltd., Chandni, Central Provinces, will make 100 tons daily of newsprint from bamboo and salai (deciduous tree). The engineering and purchasing are being handled by Ebasco Services, Inc., New York, N. Y. All equipment is to be purchased in the United States.

* * *

Huck Co., 37 Wall St., New York 5, N. Y., has announced the first instrument on the market for measuring the drying of printing inks. This instrument developed by Everett F. Carman, a member of TAPPI, will automatically test 24 printing inks on paper at one time and will make a record for 26 hours. It also has attachments for rub and scratch tests. It is called the Ink Dryograph.

* * *

Companies that recently have become sustaining members of the Technical Association include

Sindar Corp., New York, N. Y.
Smith & Winchester Co., South Windham, Conn.
Curlator Corp., Rochester, N. Y.
Perkins Goodwin Co., New York, N. Y.
Atlas Mineral Products Co., Mertztown, Pa.
Frank W. Egan & Co., Bound Brook, N. J.

A letter to the editor recently received stated: "I hope that you will retain the Personal Mention Department in *Tappi*. It is the first thing that I read each month when the magazine reaches me. In each issue, I knew several of the individuals mentioned and was interested to hear about them."

Col. C. H. L. Jones

Col. C. H. L. Jones, President of the Mersey Paper Co., Ltd., Liverpool, N. S., and Price Brothers & Co., Ltd., Quebec, P. Q., died on May 22. Col. Jones was born in Montreal, P. Q., on May 1, 1876, and attended McGill University. He was formerly Vice-President of the Lake Superior Pulp and Paper Co. and the Spanish River Pulp and Paper Co. During the first World War he raised and commanded the 227th battalion of the Canadian Expeditionary Force, and received the Order of the British Empire. He was a member of TAPPI since 1929.

EMPLOYMENT SERVICE

Positions Wanted

E26-49. Manufacturing executive having 28 years' experience in papermill management, production, and engineering desires to make a connection with a company manufacturing groundwood, sulphite, or kraft specialty papers.

E27-49. Chemist. 39. B.S. in chemistry. 18 years' experience largely in pulp and paper. During 12 years with one employer in charge of laboratory devoted mainly to bleaching studies on many types of pulp. Six years' experience in synthetic resin, mostly ureas and phenolics, including adhesives, lamination, heat-sealing, wet-strength, paper impregnation, water-resistant starch-resin adhesives.

E28-49. Graduate chemist. 28. Several years' experience in pulp and paper testing and research in paper coatings. Desires position as chemist or sales representative.

E29-49. Sales manager. Chemicals for paper industry. B.S.Ch.E. Familiar with paper production problems.

E30-49. Technical supt. 12 years' experience in production and development of sulphite and kraft pulp and paper, bleaching and electrolytic chlorine manufacturing.

Positions Open

P10-49. Wanted development engineer. Graduate engineer for development work on corrugated containers and container testing at large corrugated box plant in Southeast. Several years' experience in design, evaluation, and manufacture of corrugated containers required. Address P.O. Box 1828, Savannah, Ga.

P11-49. Chemist or chemical engineer with some experience in quality control and development of paperboard and converted items. In reply give training, experience, and salary expected.

P12-49. Chemist for envelope paper mill. Experience in bleach plant operation and control desirable. Mill in Middle West.

P13-49. Power plant engineer with considerable experience in maintenance for paper mill in Ohio.

P14-49. Chemist or chemical engineer for mill in Lake States region manufacturing wax papers, plain and printed specialties. Experience necessary, especially in food wrapping papers.

P15-49. Consumer representative in facial tissue mill. Must know quality.

P16-49. Technical dir. cellulose wadding and facial tissue mill. East.

P17-49. Research. Cylinder board papers. 5–10 years' experience in operation control. Chicago.

RECENT BOOKS

Encyclopedia of Chemical Technology. Edited by Raymond E. Kirk and Donald F. Othmer, Polytechnic Institute of Brooklyn, Vol. 3. The Interscience Encyclopedia, Inc., New York, 1949. Cloth, $7^1/_2 \times 10^1/_2$, 955 pages. Illustrated. $20.

As in the case of Vol. 2 (June *Tappi*, p. 74A) this review is prepared with the understanding that single volumes in the set of ten are not for sale. Subscription for the entire set is necessary.

Each subject considered is treated thoroughly and run alphabetically. Volume 1 ended with anthone, Vol. 2 with carbon, Vol. 3 starts with carbon (graphite products) and continues through such subjects as carbonyls, casein, cellophane, cells (electrolytic), cellulose and derivatives, cement, ceramics, chloramines, chlorine products to cinchophen.

Since each subject is treated by an outstanding expert it is obvious that the information is a condensation of the important facts about the manufacture, properties, and uses of the materials mentioned.

This Encyclopedia may be subscribed to through *Tappi*.

Recent Books-continued

Paper Year Book—1949. Edited by Walter Seltzer. Davidson Publishing Co., 22 East Huron St., Chicago, Ill. Cloth, $8^1/_2 \times 11^1/_2$, 592 pages. $10.

This is the 7th annual edition of this encyclopedia about paper. It has been revised and brought up to date. A new division of 100 pages is devoted to printing and fine papers. Well over 1000 different papers and paper products are described and illustrated with more than 700 photographs and 100 charts and tables. The nine major divisions cover coarse papers, paper markets, practical paper testing, wrapping papers, manufacturers addresses.

Books like the "Paper Year Book" are reviewed in *Tappi* because efforts such as this to bring together a vast amount of useful and practical trade information on an annual basis should be encouraged and supported.

Photography in Engineering. By C. H. S. Tupholm. Chemical Publishing Co., Brooklyn, N. Y., 1949. Cloth, $5^1/_2 \times 8^1/_2$, 276 pages. 262 photographs and figures. $6.50.

Among the subjects covered are: photography of drawings and documents, high-speed photography, radiography, x-ray and electron diffraction and microradiography, infrared photography, and instructional motion pictures.

Techniques of Histo- and Cyto Chemistry. By David Glick, Assoc. Professor of Physiological Chemistry, The Medical School, University of Minnesota. Interscience Publishers, New York. 1949. Cloth 6 × 9, 531 pages. $8.

This book is a manual of morphological and quantitative micromethods for inorganic, organic, and enzyme constituents in biological materials. Although emphasis is put on biochemical subjects it is interesting also because of its coverage of the microchemical techniques that are attracting so much current attention. It is, in a sense, a handbook that will have considerable reference value.

Wood Technology, Textbook of Vol. 1. By H. P. Brown, New York State College of Forestry, A. J. Panshin, Michigan State College, and C. C. Forsaeth, Syracuse University. McGraw-Hill Book Co. 1949. Cloth, 6 × 9, 652 pages. $6.

This book deals with the structure, identification, defects, and uses of the commercial woods of the United States. It is a revision of a former well-known volume on commercial timbers and is one of the American Forestry Series. More than half the book is devoted to the key for identification of the more important species. This section is highly illustrated. The first part of the book is a text in which the structure of the tree is thoroughly analyzed.

Handbook of Patents. By Harry A. Toulmin, Jr., Toulmin & Toulmin, Dayton, Ohio. D. Van Nostrand Co., New York. 1949. Cloth, 6 × 9, 800 pages. $9.

The author recognizes the danger of a book such as this being too general. He has tried to have each chapter technically correct and has used a large number of decided cases to illustrate each point. Each chapter is a guide to the successive steps that should be taken, from investigating the novelty of an idea through the preparation, prosecution, and protection of a patent. A few chapter headings indicate its contents. Patent Office Procedure; How to Keep Patent Records; How to Investigate Patent Records; Patent Rights Abroad. As the title indicates, it is a handbook.

Paper Making. A General Account of Its History, Processes, and Applications. Prepared under the direction of the Education Committee of the Technical Section of the Paper Makers' Association of Great Britain and Ireland, 1949. Cloth, $5^1/_2 \times 9$, 208 pages. Illustrated. Copies may be obtained through the Technical Association of the Pulp and Paper Industry, 122 East 42nd St., New York 17, N. Y., at $2.00 per copy.

This is the first book in a series to be published by the PMA Technical Section. It is a relatively elementary, general account of paper making, written in terms of British practice, and prepared primarily for the benefit of young men entering the industry, and as a guide to those employed on the commercial side and in associated industries.

Each chapter is written by an expert and every effort is made to combine simplicity of expression with accuracy. It is proposed that this book be followed by a series of short monographs, each dealing with a particular branch of paper making, but on more advanced and specialized lines.

Among the subjects covered are: The Nature and Uses of Paper, Fibrous Raw Materials, Pulping Methods for Wood and Other Materials, Bleaching, Beating, Paper Machine Operation, Finishing, Laboratory Service. A reading list and glossary of papermaking terms is appended.

The Technical Section is to be commended for undertaking a service such as this for the benefit of nontechnical men engaged in the manufacturing and sales departments of the industry.

Marketing of Chemical Products, The. By Robert S. Aries and William Copulsky, R. S. Aries & Associates, Brooklyn, N. Y. Overland Commercial Corp. Brooklyn. 1948. Paperbound, $8^1/_2 \times 11$, 150 pages, photo offset. $5.

Dr. Aries who is a member of TAPPI has been doing pioneering work in developing marketing of chemical products, using new technical procedures, in contrast to the former advertising market research techniques. It is evident that the authors realize that their techniques are still in the trial and error stage since they did not feel ready to present their story in the form of a cloth-bound printed text. Among the subjects treated are: Nature of chemical distribution; advertising and selling of chemicals, market research, the technical service department, and commercial development of new products and new markets.

Surface Active Agents, Their Chemistry and Technology. By Anthony M. Schwartz, Harris Research Laboratories, and James W. Perry, Mass. Inst. Technology. Interscience Publishers, New York. 1949. Cloth, 6 × $9^1/_4$, 579 pages. Illustrated. $10.

This book attempts to summarize the accomplishments of the past thirty years in developing a great number of surface active agents. A good background in organic and physical chemistry is required for a complete understanding of its contents. Special attention, of interest to the paper industry, is given to foaming, wetting, detergency, emulsification, spreading, etc.

Part I. is devoted to processes for synthesizing and manufacturing surface active agents such as the carboxy acids, sulphuric esters, alkane and alkyl sulphonates. Part II. covers the physical chemistry of agents in theory and practice and Part III. relates to the practical application of the agents to various industries, including the paper industry, which is mentioned briefly.

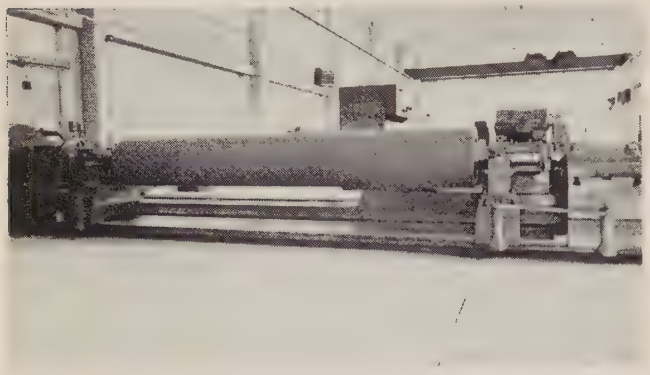
Copies may be obtained through *Tappi*, 122 E. 42nd Street, New York 17, N. Y.

* * *

Copies of all books received in this issue may be obtained through Tappi, 122 E. 42nd St., New York 17, N. Y.

Stowe-Woodward, Inc., Plant Dedicated

On June 9 Stowe-Woodward, Inc., dedicated its new addition which it calls the Ward Plant. This is located in Newton Upper Falls, Mass. This is a completely equipped factory for the manufacture of rubber rolls. The work was started on Nov. 1, 1948, and proceeded rapidly because of the mild winter. Parker B. Holden, Chief Engineer, was in charge of construction and placement of machinery. The building, as shown in the illustrations, is composed of one high bay unit and one low bay unit to form one manufacturing area, with the exception of one room partitioned off for compounding, mill, and calendering use.



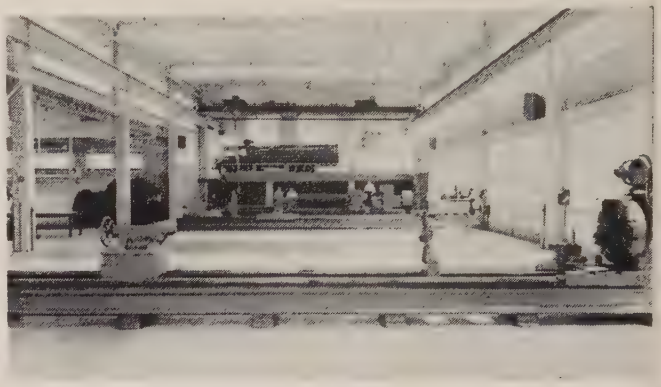
New 42-ft. 3-in. farrel rubber roll grinder. Longest and largest of its type in the United States

Milling and calendering room

Exterior view of new ward plant addition at Stowe-Woodward. Inc.

The especially designed single-wheel rubber roll grinder was built by the Farrel-Birmingham Co., Inc., Ansonia, Conn. It is the largest, longest, and most modern roll grinder in the United States. It is designed to grind and crown rubber rolls 14 to 60 inches in diameter and up to 351 inches between centers and to handle rolls up to 30 tons in weight. Its patented automatic crowning device applies a catenary curve crown up to 0.400 inch diameter. It will also grind rolls concavely with accuracy.

Other equipment includes a crane, Stewart-Bolling mills and calender, lathes, vulcanizers, and an incubator.



Looking toward elevated loading platform—ward plant, farrel grinder in rear, lathes in foreground, vulcanizers at left

Stowe-Woodward, Inc., Sales Engineers

Left to right: R. W. Holden, C. Morganstern, E. S. Green, A. F. Fisk, C. M. Schermerhorn, J. H. Glander, O. P. Arnold, B. West, H. H. Jensenius, R. P. Arnold, F. P. Thornton, Jr., W. A. Honey, J. Retallick, F. P. Thornton, Sr., and E. L. Tewksbury.

Stowe-Woodward, Inc., Newton Upper Falls Staff

Left to right: J. Mangion, P. B. Holden, A. Walker, E. W. Peterson, J. G. Lord, T. F. Kenney, E. M. Anderson, D. M. Holmberg, T. T. Ericksberg, F. L. Phelps, H. B. Shepard, C. W. Walters, H. L. Stevenson, and R. M. Leighton.

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Calendar of TAPPI Meetings

NATIONAL

General Fall Meeting, Multnomah Hotel, Portland, Ore., September 11–15, 1949.

Fourth Engineering Conference of the Pulp and Paper Industry, Statler Hotel, Boston, Mass., October 31, November 1–3, 1949.

Yes—Go West!

Then—Go East!

Paper and Packaging Specifications

FEDERAL SPECIFICATIONS

UU-B-536a (Feb. 23, 1949) Board; Binders
UU-C-282 (Feb. 7, 1949) Chipboard; Plain
UU-P-31b (March 3, 1949) Paper; General Specifications and Methods of Testing

Note: This specification covers the general requirements and methods of testing that are common to paper, paperboard, and converted paper products covered by Federal Specifications. Test methods applicable only to specific products are contained in the specifications for the products.

The specification has been considerably enlarged by the addition of many testing methods and by giving the methods in much greater detail. Twenty-nine methods are included and references are made to applicable TAPPI methods for any further details that may be desired.

UU-P-216a (Amend. 1, March 30, 1949) Paper; Detail Drawing

Ed. Note: The *Tappi* Paper and Packaging Specifications service is being continued at the request of a number of Association members. The reporting of new Federal and Army-Navy Specifications was an important feature of the *TAPPI Bulletin* during the war years and following.

In addition to Government paper contractors who need to know requirements in making bids the Specifications are recommended to all technical men dealing with paper quality in the mills. In their new 8 × 10, three-ring format the Specifications have considerable educational value since physical and chemical property tolerances are usually given as well as the specific requirements of the Army, Navy, Air Forces, and other agencies of the Government. It is apparent that there is a trend to convert the requirements of all of the services to Federal Specifications. This will greatly simplify the efforts of prospective contractors who formerly had to seek out the paper specification requirements of a large number of separate agencies.

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—with all the qualities to help you
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—at lower operating cost

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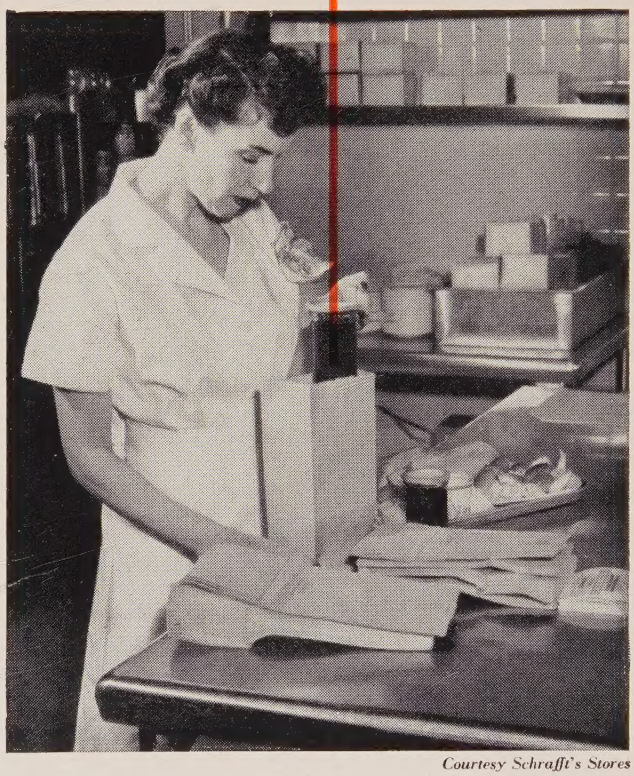

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